

NOLAN, DAVIS & ASSOCIATES

**ENVIRONMENTAL ASSESSMENT
OF HIGHWAY 104
THOMSON STATION TO MASSTOWN
Project No. EAR-104-001**

Our File No. H91462

Submitted to:

Nova Scotia Department of Transportation and Communications
P.O. Box 186
Halifax, Nova Scotia B3J 2N2

By:

Nolan, Davis & Associates (N.S.) Limited
P.O. Box 1021, Armdale Postal Station
7020 Mumford Road
Halifax, Nova Scotia B3L 4K9

In association with:

Davis Archaeological Consultants Limited

and

CEF Consultants Limited

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EXECUTIVE SUMMARY

The construction of a new, controlled-access, four-lane, divided highway between Masstown (Colchester County) and Thomson Station (Cumberland County) is proposed by the Nova Scotia Department of Transportation and Communications (NSDOTC). This 45.1 kilometre highway section will replace a portion of the existing two-lane Highway 104 between the above-noted locations.

The route was selected in an earlier phase of this study and involved the use of a multidisciplinary scoring matrix for each of four route alternatives. Considerable opportunity was provided for public involvement in the process and the proposed western alignment was clearly identified as the preferred option from both the environmental and public perspectives. The screening process is described as part of the environmental assessment report.

Provincial legislation requires that new four-lane highway alignments over five kilometres in length be categorized as Class II undertakings and be subject to an environmental assessment under the Nova Scotia Environmental Assessment Act. This report provides the results of an environmental assessment of the proposed alignment based on a review of available data, complemented with field investigations. The field investigative work was undertaken primarily from mid- September to December 1991. A second, shorter field reconnaissance was undertaken in late April 1992, to address environmental concerns related to two route changes proposed by the public and various interest groups.

A number of key environmental issues were identified and assessed based on the Terms of Reference for the study. These included the atmospheric environment, water resources, aquatic and terrestrial biology, cultural resources, land use and the social environment. A list of Valued Environmental Components (VEC's) was developed from this work and was used to determine the potential impact of the project on the environment using an impact matrix.

This matrix considered information on all facets of the proposed project including; planning activities, the construction phase and the operational phase.

Activities showing significant impacts that are non-mitigable centre primarily on contingency situations such as fuel or other hazardous material spills during the construction or operational phase. Other potentially significant impacts of concern include the effects of de-icing chemicals (ie. rock salt) on surface water, agricultural land and possibly wetlands. The assessment shows that the environmental elements most likely to be impacted, and for which there appear to be little or no opportunity to apply mitigation, to be the following:

- climax hardwoods in the right of way;
- agricultural land, including blueberry fields, in close proximity to the right of way; and
- surface water and fish in contingency situations or as a result of any failure to implement mitigative measures during construction or maintenance operations.

The greatest risk of residual impacts to the environment is associated with contingency situations during construction and operation involving major accidental spills which could impact surface and groundwaters in a currently undeveloped area. Other than applying good construction practices under the guidance of an Environmental Protection Plan, providing the safest possible conditions for the final design, and policing users of the highway, little can be done to eliminate this risk.

The control of contaminated, silt-laden runoff during construction is a major variable in terms of the potential impact of the project. To achieve adequate levels of control for the full extent of the project requires a consistent level of excellence and commitment from NSDOTC managers, designers and site supervision staff in addition to their contractors. In practice it is possible that some short term impacts to surface waters

could occur during construction due to the extreme difficulty of achieving this level of control on a consistent basis over the period of several years which it will take to construct the highway.

Alternative route alignments for two sections of the highway were considered within the scope of this study. One proposed route change near Masstown was dismissed by NSDOTC because it offered no net advantages to the originally proposed alignment. A second proposed change to the alignment, located north of the Great Village area, was also investigated by the study team and recommended for adoption because it largely avoids valuable developed agricultural lands in comparison to the initially proposed route.

The proposed project is expected to provide a number of positive impacts. Once complete it will reduce the current driving distance between Thomson Station and Masstown by approximately ten kilometres and provide a controlled access, divided highway of 100 Series standard. In addition to providing modern highway access to, and through this section of the Province, these attributes should result in reduced traffic accidents relative to the existing situation thus potentially saving lives, and reducing injuries and property damage as well as a proportionate saving in fuel consumption and vehicle emissions for the life of the project. Other positive impacts of the project include the opportunity it provides to the residents of Wentworth Valley to develop the area as a tourism/recreational based economy in accordance with the objectives expressed by many residents in the Phase I Public Attitudes Survey. The project also provides opportunities to enhance access to the West Colchester Shore which was seen to be an advantage by residents in the Phase I survey.

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PART 1

INTRODUCTION



1.0 INTRODUCTION

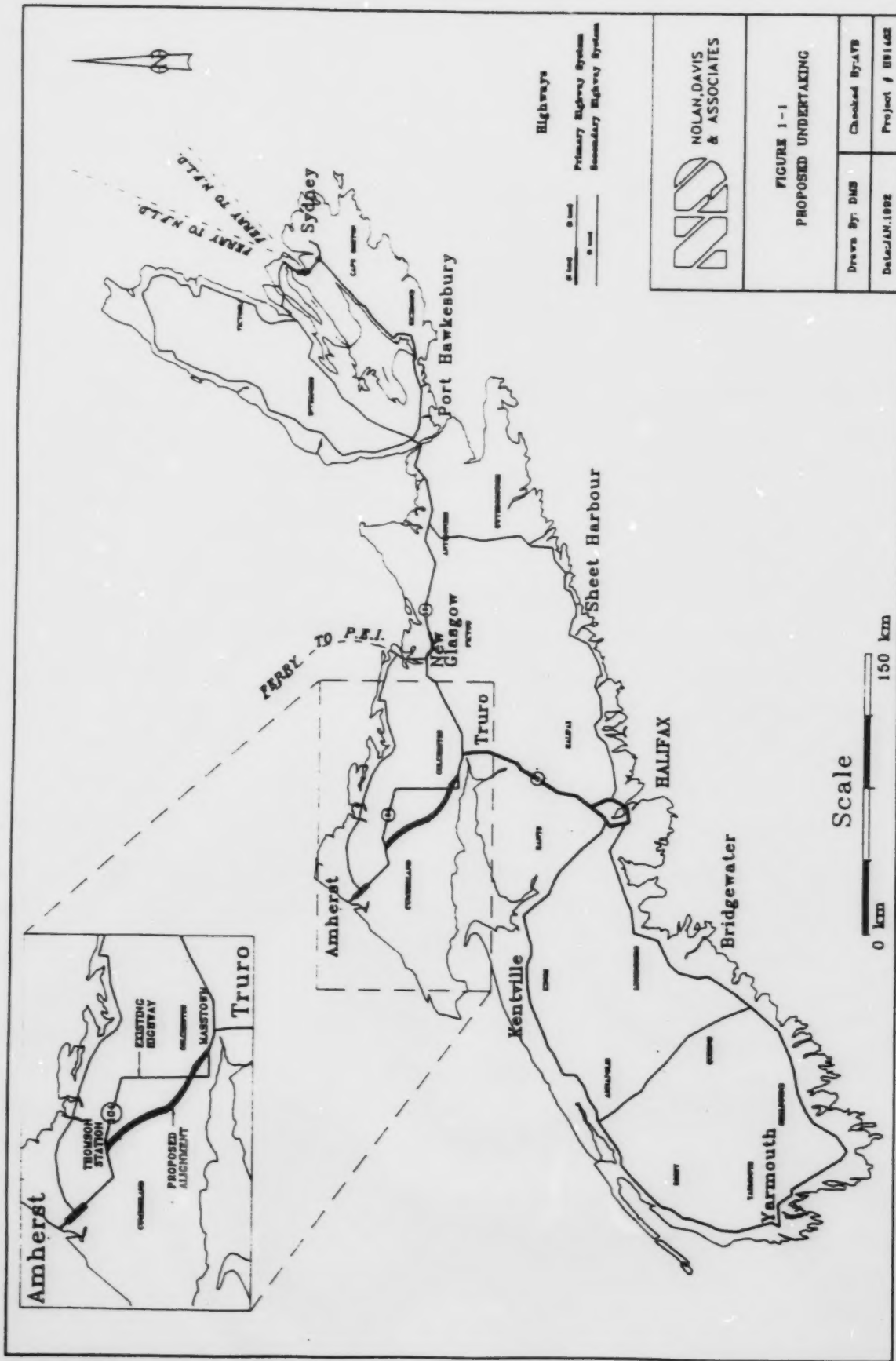
The Nova Scotia Department of Transportation and Communications (NSDOTC) is proposing the construction of a new controlled access, four-lane, divided Highway 104 to replace the existing two lane non-controlled section of Highway 104 between Masstown and Thomson Station.

Highway 104 is one of the principal provincial highways in Nova Scotia, comprising parts of the Trans Canada Highway as well as the primary road route connecting the province with the rest of mainland Canada. Since the closure of the railway in Newfoundland in 1988, the majority of freight to and from that province is by truck through Nova Scotia on this highway.

Because of the importance of highway access, its impact on Nova Scotia's economy, and concerns over safety, there is a broad public consensus across the province about the importance of upgrading the primary highways. For these reasons, the provincial government has identified Highway 104 as a top priority for upgrading to a controlled access/divided highway.

This report addresses a proposed section of new highway alignment between Masstown in Colchester County and Thomson Station in Cumberland County which will represent an important section of the overall Highway 104 upgrading program. Its location relative to the overall provincial highway system is shown in Figure 1-1. The project is described in detail in Part 2 of the report.

Terms of Reference for the environmental assessment report were approved by the Nova Scotia Department of Environment (NSDOE) on March 8, 1991. Authorization for the consultant to proceed with an assessment of the Western Alignment route alternative was given on September 27, 1991 following an announcement of the selected route by the Minister of Transportation and Communications. The route selection process proceeding this announcement is described in Section 2.1 of the report.



Since new highway alignments of this magnitude are classified as Class II undertakings in Schedule "A" of the Environmental Assessment Act Regulations, an environmental assessment report is required for the project.

The preparation of this environmental assessment report is based on a review of existing available data complemented by field investigations undertaken in the period of mid-September to December 1991, in the areas of water resources, aquatic and terrestrial biology, noise monitoring and historical/cultural resources.

The assessment is bounded by a corridor extending 500 metres each side of the proposed centerline between Masstown and Thomson Station, a distance of 45.1 kilometres. However, broader regional issues were also reviewed as a function of the earlier route selection phase (ref. Appendix 1) and provide a valuable perspective to the assessment process within the defined study corridor.

PART 2

PROJECT DESCRIPTION

2.0 PROJECT DESCRIPTION

The proposed undertaking consists of the design, survey and construction of a four-lane, controlled access, divided highway between Masstown in Colchester County and Thomson Station in Cumberland County, Nova Scotia.

The project will conform to the Transportation Association of Canada standards for Rural Freeway Divided 110 and to NSDOTC Freeway Type "A" Classifications. It will be carried out in accordance with the Nova Scotia Department of Transportation and Communications' Standard Specifications, (1980 and revisions)(which includes the "Environmental Construction Specifications,"1982), Highway Design Standards (NSDOTC 1989), and the Environmental Construction Practice Specifications (Fisheries and Oceans 1981).

2.1 Route Selection

The selection of the proposed route resulted from an Environmental Screening Study conducted by Nolan, Davis and Associates which concluded that the "Western alignment" was the preferred of four possible alignments in terms of potential impact to the biophysical and socio-economic environment of the region. The four alternatives are shown in Figure 2-1. An executive summary of the screening report is included as Appendix 1. A numerical screening matrix, shown in Figure 2-2, was used to score and rank the alternative routes and clearly pointed to the chosen route based on the parameters reviewed. A summary of the screening results is given in Table 2-1. The positive and negative aspects of the Western alignment are summarized in Table 2-2.

The public perception component of the screening study supported this finding and determined that the Western alignment was regarded positively by most persons surveyed because it avoids the Wentworth Valley, maintains the close link to the Debert Industrial Park, and provides a "suitable" highway corridor in terms of distance and weather conditions. It was, however, opposed by interests on the North Shore because of the lost opportunity for improved access to that region.

FIGURE 2-2

Numerical Screening Matrix

Environmental Parameter	Parameter Weighting 0 to 5	Registered Alignment		Western Alignment		Central Alignment		Eastern Alignment	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Fuel consumption	5	2	10	1	5	0	0	3	15
Proximity to water supplies.	3	4	12	1	3	3	9	5	15
Proximity to archaeological sites	3	3	9	4	12	2	6	1	3
Hydrology/hydrogeology	2	4	8	2	4	3	6	3	6
Weather conditions	4	1	4	2	8	1	4	3	12
Rare and endangered species	4	3	12	2	8	4	16	3	12
River crossings/fish habitat	2	3	6	2	4	3	6	4	8
Wetland habitat	2	3	6	4	8	3	6	2	4
Wildlife	2	2	4	1	2	3	6	4	8
Geology/acid generation	1	2	2	1	1	2	2	3	3
Erodible soils/soil failure	1	3	3	1	1	2	2	2	2
Parks and reserved lands	1	3	3	0	0	3	3	0	0
Cemeteries	2	1	2	1	2	1	2	1	2
Utilities	1	1	1	1	1	1	1	1	1
Noise and dust levels	2	4	8	1	2	3	6	2	4
Agriculture (existing and potential)	3	2	6	3	9	1	3	1	3
Recreation	3	5	15	1	3	4	12	3	9
Residential	4	5	20	1	4	4	16	2	8
Existing commercial	1	1	1	3	3	2	2	3	3
Development potential	3	4	12	1	3	4	12	0	0
Totals -unweighted		56	XXX	33	XXX	49	XXX	46	XXX
Totals-weighted		XXX	144	XXX	83	XXX	120	XXX	118
Rank		4	4	1	1	3	3	2	2

Notes: Score: 0 - no impact; 5 - high impact.

Weight: 0 - no importance; 5 - high relative importance.

Lowest total is preferred environmental option.

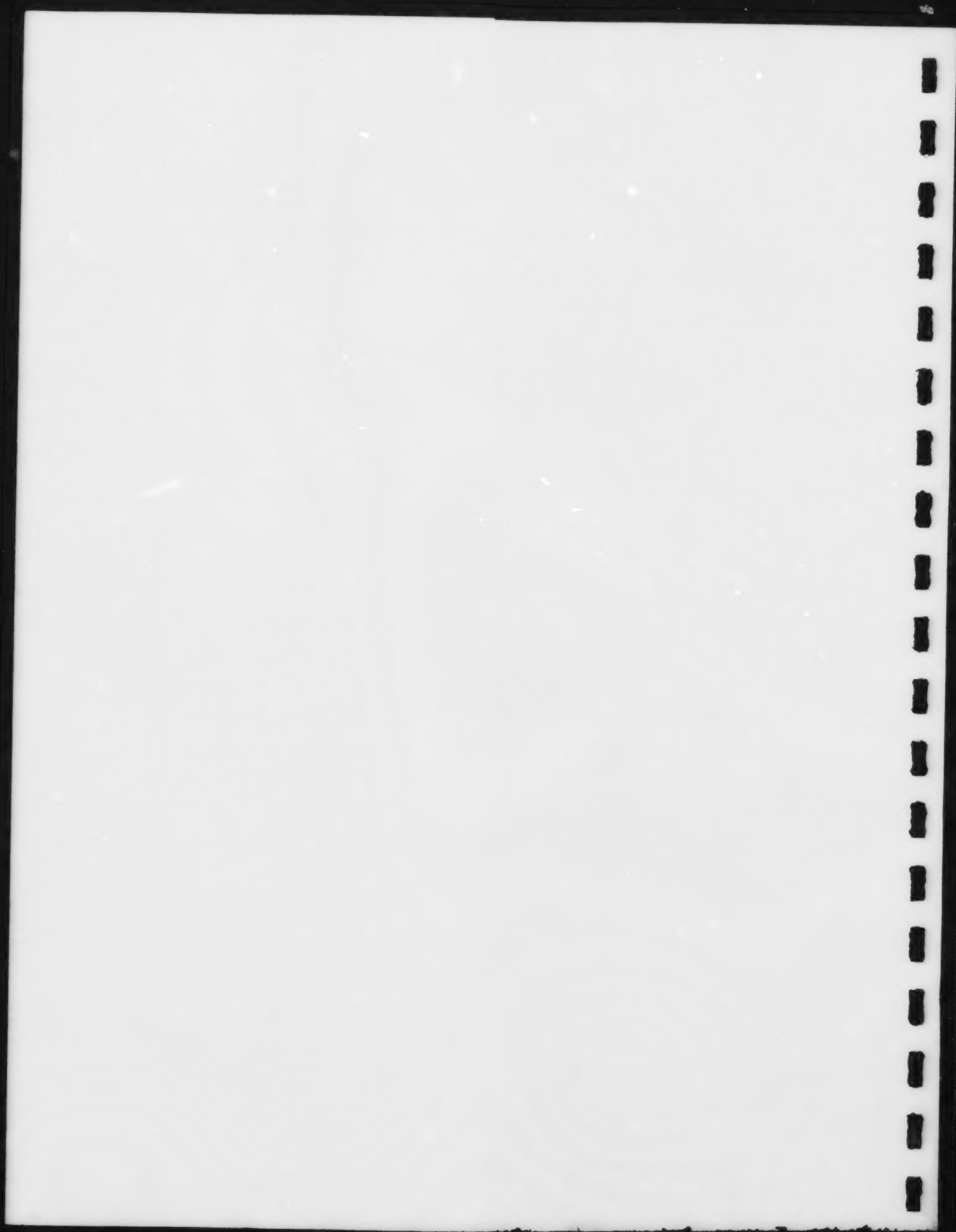


FIGURE 2-1
ROUTE ALTERNATIVES
CONSIDERED IN PHASE 1



NOLAN, DAVIS
& ASSOCIATES

Drafted By N.P.

Checked By G.C.

Dated Aug. 1991

Project No. H91462

-  KNOWN INTERCHANGE LOCATIONS
-  POSSIBLE INTERCHANGE LOCATIONS

SCALE 1:150 000

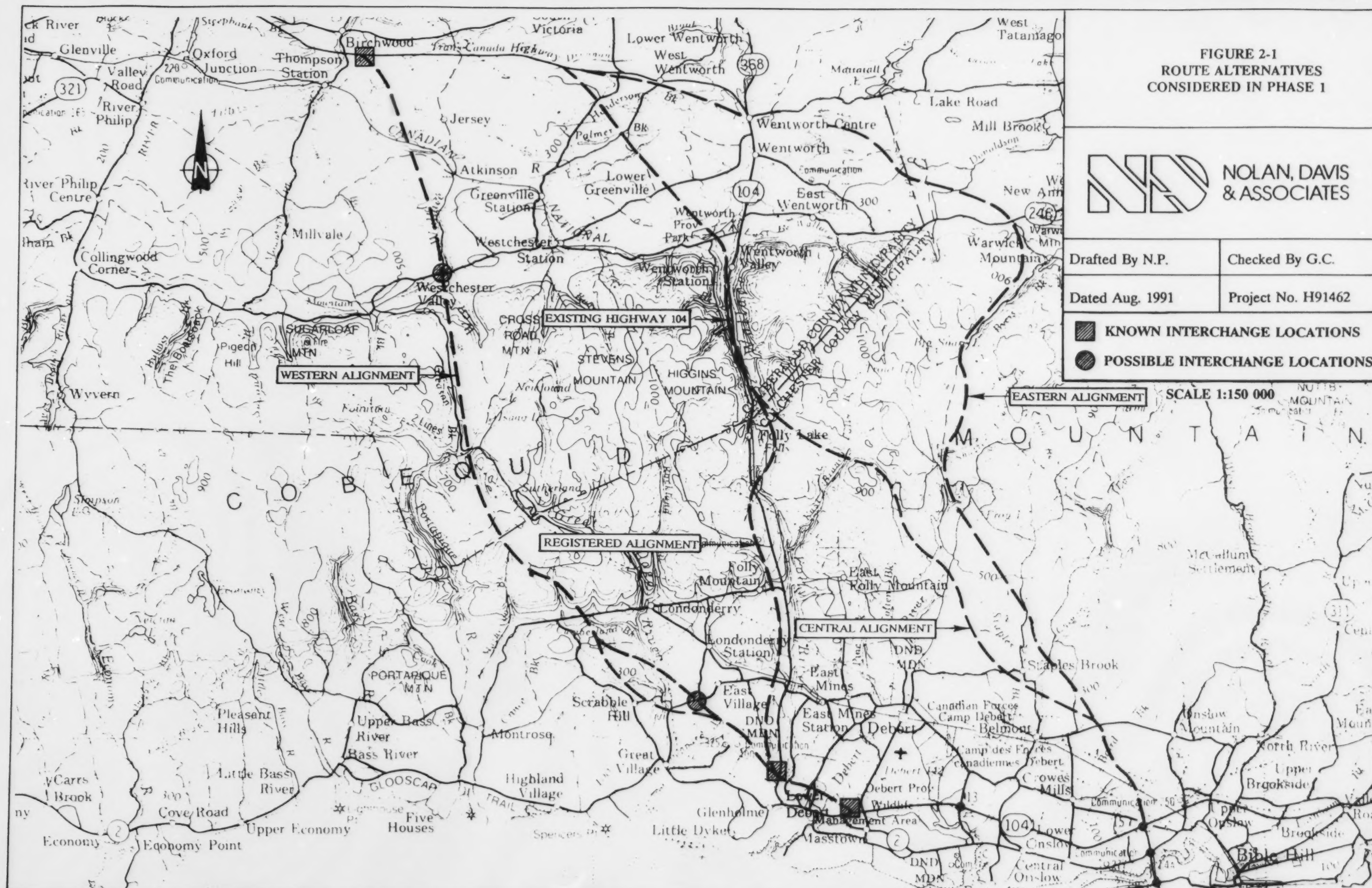




TABLE 2-1
Summary of Environmental Screening Results

Alignment	Weighted Score ^a	Ranking
Western	83	first
Eastern	118	second
Central	120	third
Registered	144	fourth

^a Refer to Figure 2-2 for details

2.1.1 Public Participation

The route selection process as well as the environmental assessment has involved the public in the following ways:

- public information open house at Masttowne Motel and Wentworth Fire Hall in the Fall of 1990 at which all interested parties were invited to meet with NSDOTC officials to review the Registered Route option.
- public information open house at Debert Industrial Complex on June 18, 1991 at which all interested parties were invited to meet with NSDOTC officials and the consulting team and to provide input to the route selection process.
- as above but meeting held at Wentworth Recreation Center on June 19, 1991.
- public perception study conducted by the consultant as part of the route selection process involving all interested parties on each route alternative as well as other regional interests.
- distribution of a **104 Update** newsletter to all residents and other interested parties for all proposed routes describing the route selection and environmental processes with return questionnaire and contact names and numbers.
- meetings with various interest groups by the consulting team including agricultural and trucking representatives as well as a group representing the interests of the North Shore region.

Table 2-2

**List of Advantages and Disadvantages
Western Alignment ^{a)}**

<u>Advantages</u>	<u>Disadvantages</u>
• low population density • low number of water supply wells • maintains good access to Debert Industrial Park • good scenic potential (tourism) • low potential for acid drainage sites (no known sites) • mostly small stream crossings • least impact on recreational resources • low impact on deer and moose • second shortest route • least limited for future expansion • enhances access to West Colchester shore	• cannot construct in phases • does not enhance access to North Shore area • impacts most agricultural lands at south end and blueberry barrens further north • potential weather problems on high ground • highest number of known heritage sites • potential for some noise impact at Sutherlands Lake cottage area • north end could have potential for rare species and impact on furbearers and wetland habitat

a) From Interim Report

- meeting of invited representatives for residents and other interest groups on each route alternative as a "consultative workshop" to review the advantages and disadvantages of each route option and identify potential scoring factors. Held on July 17, 1991 at the Wentworth Recreation Center.
- public information open house at Debert Industrial Complex on October 22, 1991 to provide property data and other information relative to the chosen alignment (ie Western Alignment).

2.2 Overview of the Selected Alignment

The most striking characteristics of the route are its relatively low population density and its topographical features as it crosses the Cobequid Highlands at a peak elevation of approximately 277 metres. These will provide ample opportunities for the route to provide a very scenic section of highway.

Residential land use involving groupings of ten or more private dwellings within the proposed western corridor occur at four locations, namely Thomson Station, Scrabble Hill, east of Great Village, and north of Glenholme. The remainder of the corridor is generally uninhabited, but passes through a variety of land-use areas and habitats. The following discussion briefly describes the proposed route in a regional context. A detailed description of the existing environment is provided in Section 6.0.

Near Thomson Station, at the north-western extremity of the proposed corridor, the alignment parts from the existing Highway 104 and turns southward, passing through an area consisting primarily of small wetlands and pine forest for approximately 11 kilometres. Blueberry cultivation and clearcut logging are the dominant land uses. The terrain is relatively flat here and the alignment traverses a series of low gradient watercourses.

Continuing southward, the alignment ascends the north slope of the Cobequid Mountains over a distance of approximately four kilometres to reach an altitude of 277

metres. The maximum highway slope needed for this ascent is six percent. Two tributaries of the West Branch Wallace River are traversed along the slope. Blueberry cultivation is the dominant land use.

Crossing the top of the Cobequid Mountains, the corridor parallels the existing Westchester Road for some five kilometres and then descends to the Portapique River. Land use along this section consists of extensive blueberry cultivation and logging of the white spruce flats. After crossing the Portapique River, the proposed alignment climbs again to a plateau elevation of approximately 260 metres for another five kilometres before beginning an abrupt descent to the Minas Lowlands. The upper slopes are characterized by hardwood forests and the middle to lower slopes by coniferous forests and agricultural land. Blueberry cultivation is less significant along this section of the corridor.

At the base of the south slope of the Cobequids, the corridor alignment turns eastward passing immediately northeast of the community of Scrabble Hill. The Minas Lowland section of the corridor, between Scrabble Hill and Masstown, is the most densely settled and developed. It crosses the Great Village River, passing north of the town of Great Village and the Department of National Defence Compound. At the southern end of the alignment, the corridor intersects the existing Highway 104 and crosses both the Folly and Debert Rivers before rejoining Highway 104 at the Masstown Road. Much of the land within the Minas Lowland section of the corridor is of notably good agricultural potential, although present levels of cultivation are limited. The primary land-use within this section of corridor is clearcut logging.

A summary of the key physical features of the route as currently defined can be summarized as follows:

- | | | | |
|---|--|---|-----------------|
| - | Approximate Alignment Length | - | 45.1 kilometres |
| - | Approximate Right-of-Way Area | - | 406 hectares |
| | (Excluding interchanges and assuming a width of 90 metres) | | |

-	Number of Watercourse Crossings	-	17 (see Section 6.4)
-	Road Crossings	-	nine
-	Rail-line Crossings	-	one
-	Powerline Crossings	-	three
-	Maximum Elevation	-	277.5 metres
-	Maximum Road Grade	-	6.0 percent

Features such as the route's proximity to water supplies, historical and cultural sites, and land-use are described in Section 6.0. At the present time the location of three interchanges is known as indicated on Figure 2-1. There is a possibility that one or two other interchanges will be constructed along the route (see Figure 2-1). Further description of the interchanges is included in Section 7.6.

2.3 Construction Schedule

The proposed corridor provides little flexibility to phase the construction of the highway such that incremental benefits could be derived from the project before it is entirely completed. However, two phases are proposed: construction is likely to begin with the Masstown bypass which branches from the existing highway at the southern extremity of the alignment and by-passes the developed service area to intersect the existing highway again further north. If approvals are in place, this section could be started in May 1993 and be completed by November 1994.

The remainder of project will be constructed at a schedule dictated by the availability of funding, but could be completed within four to five construction seasons if sufficient funds are available. Thus, if approvals for construction are in place by December, 1992, the entire section of highway in question could be in operation by late 1998 under ideal conditions.

2.4 General Highway Construction Practices

This section provides a brief overview of the construction activities anticipated for the proposed undertaking.

Highway development contains two relatively separate construction elements: roads and structures. Because the two elements require somewhat different equipment, materials and skills, they are normally undertaken as separate contracts. The following discussion will therefore review each of these elements separately.

2.4.1 Roads

The first phase of construction activity, following the survey of the route, is the clearing of the right-of-way. A typical four-lane divided highway requires a standard right-of-way width of 90 metres. The geometry of the highway and topographical features may dictate variations in this width. Right-of-way clearing usually involves the use of chainsaws, or in some cases, mechanized tree cutters. Merchantable material is transported using tractor-skidders that haul the logs to centralized stockpiles. From the stockpile, the logs are loaded by porters onto trailers and removed from the site. Limbs and other non-merchantable materials are normally moved to chippers or burning piles by tractor-drawn brush rakes. Burning is usually initiated with gasoline or a similar product.

Grubbing for roadway construction is the process of rootmat and topsoil removal. All areas where the fill is less than 1.5 metres, or where excavation is planned, are grubbed. Areas to be covered by deep fills (greater than 1.5 metres) are only grubbed where a structure foundation such as a bridge, culvert or retaining wall, is to be constructed.

Grubbing is usually conducted with bulldozers, which are used to scrape the organic material and topsoil off of the underlying soil and to push it to a desired location. If the grubbed material is to be removed from the site, track-mounted excavators are usually used to load the material onto trucks. Where grubbing involves the removal of extensive organic deposits (i.e. peat), the material is usually removed by an excavator and loaded directly into dump-trucks. If the deposit of unsuitable material is too wet to be removed with an excavator, it is sometimes displaced by dumping rock or fill materials into the low area.

Subgrade development refers to the alteration of the vertical and horizontal geometry of the proposed right-of-way by means of excavations and embankments. Drainage patterns along the right-of-way are established such that runoff is directed into the natural drainage regime in an acceptable manner. This process of subgrade and drainage development comprises the major portion of highway construction in terms of duration and cost.

Following the completion of a subgrade, a granular structural base is developed for the roadway. Graded aggregate is delivered by trucks and then spread by graders and compacted by vibratory rollers. Weather permitting, this is normally an activity of short duration.

Paving involves either the spreading and compacting of petroleum based asphalt pavement or alternatively, the pouring of cement concrete onto the compacted granular base.

2.4.2 Highway Structures

Highway structures include bridges, overpasses, culverts and other drainage structures. Construction of a bridge frequently precedes completion of the roadway. Foundations are often constructed of cast-in-place reinforced concrete, although piled foundations are also sometimes used. Prefabricated beams are then put into place using cranes and the bridge deck is then constructed of cast-in-place reinforced concrete.

Culverts may be built of corrugated metal or of concrete. The sizes of culverts are determined by estimating the rate of surface runoff discharge from the area draining to the culvert. All watercourse crossings are designed to accommodate the 1 in 100 year storm for the local region.

2.4.3 Standard Environmental Protection Practices

Standard Environmental Construction Practice Specifications were incorporated into the NSDOTC Standard Specifications in 1982. Furthermore, all highway construction activities in Nova Scotia are subject to the Environmental Protection Act and the Water Act. Contractors are therefore required to conduct their work so as to conform to these Acts. Relevant environmental protection practices and guidelines required in the Province are outlined in the following subsections.

2.4.3.1 Geotechnical Survey

As part of the pre-design geotechnical survey of a proposed alignment, rock and overburden soil samples are collected and chemically and physically analyzed. The results may be used to plan environmental protection measures for the various construction phases.

2.4.3.2 Erosion and Sediment Control

The principles of erosion and sediment control are well understood and methods of mitigating impacts and minimizing risk have been fully developed. The Nova Scotia Department of Environment "Erosion and Sediment Control Handbook for Construction Sites" is used as the reference document for all erosion and sediment control measures. Five relevant principles are outlined:

1. Fit the activity to the topography, soils, waterways and natural vegetation of the site;
2. Expose the smallest practical area of land for the smallest possible time;
3. Apply on-site soil erosion control practices as a first line of defence;
4. Apply sediment control practices to prevent off-site damage; and
5. Implement a thorough maintenance operation.

Control plans are developed before earth moving equipment disturbs the site. Detailed geotechnical surveys conducted in advance of the construction provide soils information that is used to predetermine the control measures required. Environmental risks associated with erosion/sedimentation are minimized through surface runoff management. Prior to grubbing, ditch drainage systems are developed within the highway right-of-way to control surface runoff. Siltation control devices such as geotextile silt fences, sedimentation ponds and silt traps are developed by the contractor as part of the grubbing operation and maintained during the subgrade and drainage development operation. NSDOTC has developed standard specifications for these devices.

Excavation and embankment slopes are hydroseeded after the area has been brought to grade. In special circumstances, a layer of crushed or blasted rock may be used on slopes as a long-term erosion prevention measure. The use of straw mulches is one of a number of techniques which have been used as an interim measure for erosion prevention.

Phases of construction may be restricted to designated low risk periods of the year. Clearing operations, for example, are best carried out in winter on frozen ground making it easier to use heavy equipment without disturbing the ground. The installation of culverts on the other hand may be prohibited during periods of fish spawning and high runoff and are therefore often constructed during the dry summer season.

2.4.3.3 Excavation and Blasting

Excavation and blasting may be required within the right-of-way for the development of the highway grade and within pit and quarry areas which are usually in close proximity to the right-of-way. All borrow material and gravel pit or quarry aggregates must be approved by the NSDOE with respect to their acid production/consumption properties and the heavy metals contained. If slates are encountered the NSDOE "Guidelines for Development on Slates" (1991) and the NSDOTC "Approval Process for Pits Containing Slates" are followed.

Pit and Quarry Guidelines (1988), developed by NSDOE and included in the NSDOTC Standard Specifications, provide environmental standards for the excavation of borrow and aggregate material. Standards include minimum separation distances, rehabilitation practices, discharge limits and, acceptable dust, sound and air blast limits.

The method used for rock excavation depends on the type of rock and the depth and volume to be excavated. Major rock excavations often involve blasting. Provincial and municipal regulations govern the blasting operation. Carried out in accordance with these regulations, blasting should not create a problem. NSDOTC expects its contractors to carry blasting insurance when blasting is required. Prior to blasting, the contractor's insurer will normally conduct a pre-blast survey, in which the state and condition of structures and water wells are defined. If damage occurs during blasting, data from the pre-blast survey will be used to resolve claims.

2.4.3.4 Disposal of Waste Material

Once highway construction is initiated, excess materials (rock, overburden and waste organic material) will have to be disposed of in a proper and acceptable manner to NSDOE and the respective officials of Cumberland and Colchester counties.

According to D. Hynick, NSDOE, a permit to dispose of construction debris is not required from the Department of Environment. Legislation enacted in 1992 by the Province states that NSDOE is divesting itself from regulating the disposal of construction debris. County officials will be responsible for deciding the location of disposal sites for construction debris.

It will therefore be necessary for NSDOTC and its contractors to meet with Cumberland and Colchester County officials, to select suitable locations for the disposal of construction debris prior to construction. Ideally these should be in close proximity to the right of way. New sites will be chosen so as to avoid impact to watercourses, groundwater supplies, sensitive habitat and private property. All waste piles will be properly graded and

seeded.

There are a number of waste disposal sites existing in Cumberland and Colchester counties and depending on the location of highway construction, some of these sites may potentially be cost effectively utilized for the disposal of construction debris. However, Mr. J. Jensen, County Planner for the Municipality of Cumberland County, indicated that "major changes" are in order for the county's waste management system in 1992. Existing waste disposal operations near the existing Highway 104 will either become transfer stations or closed down completely.

The Municipality of Colchester County has two waste disposal operations in close proximity to the proposed alignment. Discussions with Mr. A. MacKinnon, Town of Truro Engineering Office, indicated that the town landfill would accept waste rock, overburden, and most grubbing debris. Organic soils, if uncontaminated, would be disposed of in approved sites along the route. County officials noted that the Truro landfill is nearing its capacity and a possible alternative site is currently being investigated near Irishtown.

A "burn and cover" operation is situated in Portapique (Bass River) and accepts waste from areas in the local vicinity. Mr. S. Bishop, County Engineer for the Municipality of Colchester County stated that this waste disposal site currently accepts waste rock, overburden, organic soils and grubbing debris. There also is an area designated for stockpiling derelict vehicles.

2.4.3.5 Asphalt Paving Plants

Asphalt paving plants are regulated under the Nova Scotia Environmental Protection Act. The Asphalt Paving Plant Regulation (1978) limits separation distances, water effluent, air emissions, area maintenance and noise levels.

2.5 Engineering Requirements Specific to the Undertaking

Features which must be addressed in the engineering design of the highway such as water supplies, historical and cultural sites, and land-use are described in Part Six.

2.5.1 Areas Requiring Major Excavation and Embankment Operations

A series of major excavation and embankment (cut and fill) operations will be required to construct the highway subgrade through the topography of the proposed alignment. The location of these areas are shown in Figure 2-3. For the purpose of this report, a major cut or fill is defined as follows:

1. Within 0.5 kilometre km of a watercourse, any cut or fill operation which exceeds five vertical metres at any point along its length;
2. For areas not within 0.5 kilometre of a watercourse, any cut or fill operation which exceeds ten vertical metres at any point along its length.

Details on the cuts and fills are identified on Figure 2-3 and described in Table 2-3.

2.5.2 Borrow Material

Figure 2-4 identifies surficial deposits of glacial origin and quarries located in close proximity to the proposed corridor. These potential sources of borrow materials may be utilized for fill sections, subgrade, and as aggregate in construction of the highway.

All borrow material for use on NSDOTC construction contracts must be located and procured by the contractor. Any material proposed to be used as borrow, must be approved by the Department Engineer. The contractor must not only procure the material, but also transport it to the job site at no additional cost above the tender price. Generally, materials which would not be approved for use by the Department's Engineer would be those containing a significant amount of organic material of those which would produce acidic runoff.

TABLE 2-3

DETAILS OF CUT AND FILLS

Kilometrage			Kilometrage		
1. FILL	C/F inter	1 + 900	13. CUT	c/f inter	24 + 050
	5 m	1 + 680		5 m cut	23 + 960 watercourse @ 24 + 420
	5.5 M max	watercourse @ 2 + 090		8.5 m max.	23 + 880
	5 m	1 + 570		5 m cut	23 + 700
2. FILL	c/f inter	1 + 440		c/f inter	23 + 630
(2+400)	c/f inter	2 + 650	4. FILL	c/f inter	24 + 720
	5 m fill	2 + 480	(watercourse)	5 m fill	24 + 410 watercourse @ 24 + 420
	5.5 M max	watercourse @ 2 + 450		6.5 m max.	24 + 383
	5 m	2 + 440		5 m fill	24 + 370
3. FILL	c/f inter	2 + 400		c/f inter	24 + 050
(Till/scr	c/f inter	6 + 015	15. (FILL)	c/f inter	26 + 655
CNR)	5 m fill	5 + 980	Spencer Road	5 m fill	26 + 630
	max 15 m			13 m fill	26 + 550
	5 m fill	3 + 330		5 m fill	26 + 350
	c/f inter	5 + 235		c/f inter	26 + 290
4. FILL	c/f inter	7 + 825	16. CUT	c/f inter	27 + 090
(W.C.)	5 m fill	7 + 770 watercourse @ 7 + 615	Near Spencer	5 m cut	26 + 900 watercourse @ 26 + 570
	6 m max		River (26	8 m max.	26 + 710 (Spencer River)
	5 m fill	7 + 690	+ 570)	5 m cut	26 + 690
	c/f inter	7 + 600		c/f inter	26 + 655
5. FILL	c/f inter	10 + 760	17. FILL	c/f inter	27 + 490
	5 m fill	10 + 530 watercourse @ 10 + 940	(W.C. 27	5 m fill	27 + 440 watercourse @ 27 + 410)
	5.5 m fill max.		+ 410)	max. 11.5	27 + 410
	5 m fill	10 + 490		5 m fill	27 + 120
	c/f inter	10 + 195		c/f inter	27 + 090
6. FILL	c/f inter	11 + 265	18. FILL	c/f inter	29 + 385
(W.C. 10	5 m fill	11 + 080	(Cum. Brk.)	5 m fill	29 + 230
	13 m max.			(max. -15 m)	
	5 m fill	10 + 840		5 m fill	29 + 030
	c/f inter	10 + 760		c/f inter	28 + 610
7. FILL	c/f inter	12 + 390	19. CUT	c/f inter	29 + 810
	5 m fill	12 + 280	Near Cum. Bk.	5 m cut	29 + 590
	8.5 m max			6 m max.	29 + 575
	5 m fill	12 + 140		c/f inter	29 + 385
	5.5 m	12 + 110		c/f inter	32 + 640
	5 m	12 + 070	20. FILL	c/f inter	32 + 400
	12.5 m max		Moose Bk.	c/f inter	32 + 200
	5 m fill	11 + 750		c/f inter	33 + 280
	c/f inter	11 + 520	21. CUT	c/f inter	33 + 280
8. FILL	c/f inter	13 + 885		5 m fill	33 + 020 watercourse @ 33 + 570
(Gleason Rd.)	5 m fill	13 + 850		8.5 m max.	32 + 865 (Moose Brook)
	11 m max.	13 + 740		5 m fill	32 + 810
	5 m fill	13 + 630		c/f inter	32 + 640
	c/f inter	13 + 470	22. (FILL)	c/f inter	34 + 685 watercourse @ 34 + 825
9. CUT	c/f inter	14 + 290		5 m fill	34 + 970 34 + 838 (Great Village
	5 m fill	14 + 170		max. 7 m fill	34 + 480 River)
	11 m max.	13 + 970		5 m fill	34 + 480
	5 m cut	13 + 910		c/f inter	34 + 330
	c/f inter	13 + 885	23. FILL	c/f inter	35 + 020
10. FILL	c/f inter	18 + 445	G.V. River	5 m fill	34 + 970
18 + 365	5 m fill	18 + 410 watercourse @ 18 + 365		10 m fill	34 + 910
W.C.	7 m max			12.5 fill	34 + 820
	5 m fill	18 + 310		c/f inter	34 + 775
	c/f inter	18 + 270	24. FILL	c/f inter	41 + 600
11. CUT	c/f inter	19 + 790		5 m fill	41 + 580
	5 m cut	19 + 750 watercourse @ 18 + 365		max fill 13.5 m	41 + 450
	max 9 m			5 m fill	41 + 150
	5 m cut	19 + 520		c/f inter	41 + 000
	c/f inter	18 + 950	25. CUT	cut/fill inter	41 + 850
12. CUT	c/f inter	19 + 980		5 m cut	41 + 770 watercourse @ 41 + 465
Portapique River	5 m fill	19 + 950		max cut (7.5 m)	41 + 620 41 + 490 (Folly River)
	14.5 m max.			cut/fill inter	41 + 600
	5 m fill	19 + 850			
	c/f inter	19 + 790			

Note: Kilometrage based on 1:10000 mapping

Borrow material is almost always obtained from a pit and the Department is responsible to ensure that the pit meets the Pit and Quarry Guidelines.

There are several localities which may be considered potential sources of aggregate. Prime (1991) has identified aggregate operations currently listed as active in the region. The competent bedrock which comprises the Cobequid Highlands represents a good potential for aggregate. However, there are no known bedrock quarries situated within the corridor of the study area at this time.

An aggregate source must be approved by NSDOTC based on the NSDOE "Pit and Quarry Guidelines". All aggregate, alone or as a pavement component, must conform to the Standard Specifications of NSDOTC (1980 and revisions).

2.5.3 Proposed Pavement Structure

Pavements proposed for use on the roadway will be the same as those used on other provincial highways. Roadway subgrade will be determined by the existing soil conditions along the alignment with fill derived from local soil overburden. Sub-base and base materials will consist of standard granular aggregate materials produced from sources in the project area.

Paving materials can be either portland cement concrete (PCC) or asphalt cement concrete (ACC). However, PCC is normally more expensive than ACC. Although PCC has a considerably longer life expectancy with lower initial maintenance, consideration of that life expectancy by present value analysis methods is still not able to justify the additional initial costs for most types of pavement cross-section. Construction of this project is therefore more likely to make use of asphaltic cement concrete pavement placed on standard base materials.

Both types of pavement have indirect environmental implications. Manufacture of ACC pavement results in emissions during the refining of the asphalt cement



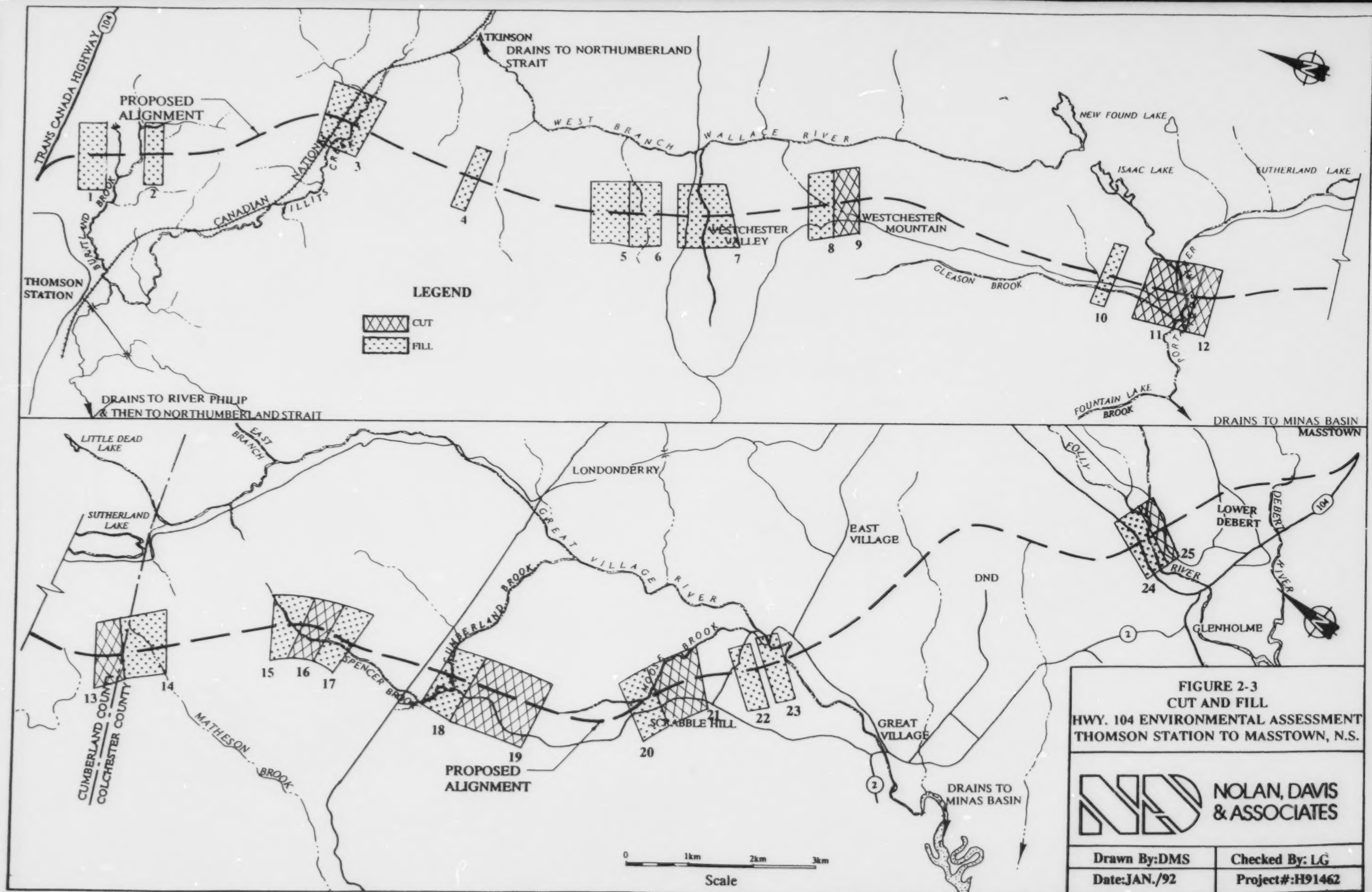


FIGURE 2-3
CUT AND FILL
HWY. 104 ENVIRONMENTAL ASSESSMENT
THOMSON STATION TO MASSTOWN, N.S.



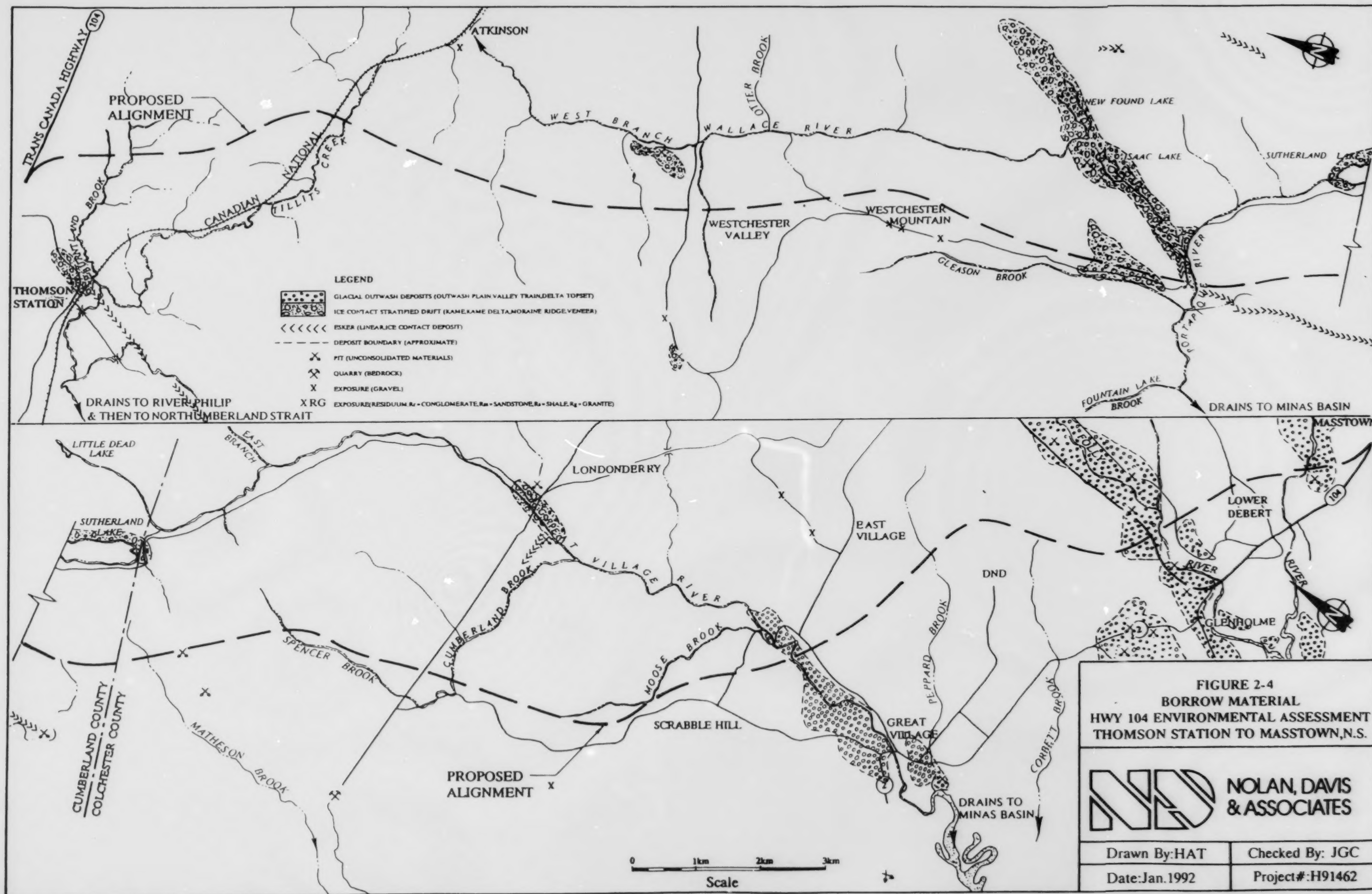
**NOLAN, DAVIS
 & ASSOCIATES**

Drawn By: DMS

Checked By: LG

Date: JAN./92

Project #: H91462



in the refinery, during manufacture of the aggregates and the mixing of the ACC paving material. PCC pavement results in emissions during the manufacture of the cement, during manufacture of aggregates and during the manufacture of the paving materials. Both binding materials (asphalt cement and portland cement) are manufactured in Nova Scotia in facilities with environmental licences for that purpose.

2.5.4 Construction Vehicle Operations

Subgrade construction typically requires the use of excavators, dozers, off highway trucks, and graders. Most of these vehicles operate on diesel fuel and typically operate continuously for 12 hour shifts. Vehicles used in pavement construction include rollers, graders, highway trucks and asphalt pavers.

Truck traffic would normally be confined to on-site operations. However, off-site transport of material may be required if adequate borrow or waste disposal sites are not available close to the alignment, or if the asphalt paving plant is not located on-site. There are a limited number of existing roads along the northern 3/4 of the alignment that could be used during construction as access roads. Existing traffic levels on these roads (with the exception of Highway 104) are low.

Contractors are permitted to continue construction operations 24 hours per day. However, NSDOE Pit and Quarry Guidelines (1988) and Asphalt Paving Plant Regulations (1978) set the following sound level limits to be observed at site boundary limits:

Energy Equivalent Sound Level Limits (L_{eq})

Day (07:00 - 19:00 Hrs)	65 dBA
Evening (19:00 - 23:00 Hrs)	60 dBA
Night (23:00 - 07:00 Hrs)	55 dBA

2.5.5 Community Information and Public Liaison

A Construction Site Committee may be set up with representation from at least the Nova Scotia Department of Transportation and Communications, Nova Scotia Department of the Environment, the General Contractor, local municipal representatives and interest groups to monitor the environmental protection measures and concerns during construction.

2.6 Highway Operational Considerations

During the lifespan of the highway it will be necessary to undertake normal operational and maintenance operations including the following:

- Resurfacing and repair of the pavement surface as required including periodic regrading of the shoulders
- Periodic maintenance of bridges and drainage structures
- Vegetation control along the right-of-way to maintain sight lines and other safety considerations. This could involve both mechanized cutting and herbicide control. The latter would be carried out under the supervision of the Nova Scotia Department of Agriculture
- Winter maintenance such as snowplowing and the application of rock salt (NaCl) for ice control. The maintenance standard for 100 series highways in Nova Scotia is "bare pavement". Typically this requires an application of about 20 tonnes of salt per kilometre of series 100 highway per winter season, but amounts vary depending on local conditions and severity of the season. Road salt may include anticaking agents such as ferric-ferrocyanide or sodium ferrocyanide, the potential effects of which are discussed in Section 7.2.1.2. At the current time NSDOTC obtains its de-icing salt from the Canada Salt Company Ltd. in Pugwash, Nova Scotia. Sodium ferrocyanide is added as an anticaking agent by the supplier. The Material Safety Data Sheet on this substance provided by Canadian Salt states this substance as having "a low level of toxicity".

PART 3

REASONS FOR THE UNDERTAKING



3.0 REASONS FOR THE UNDERTAKING

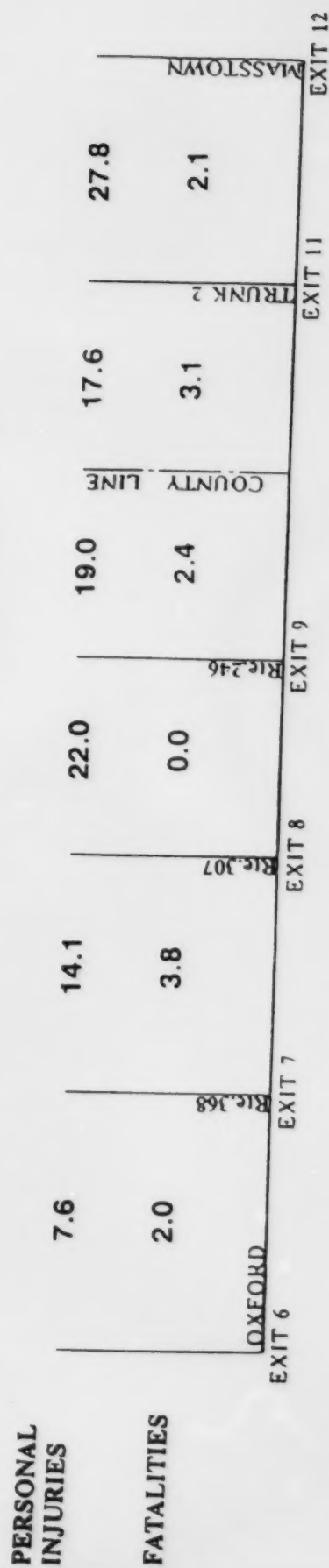
The main objective for this undertaking is to provide a 100 series highway between Thomson Station and Masstown consistent with the Province's policy of upgrading its major routes to controlled access, divided highways. This policy is motivated by the demands of increasing traffic volumes, greater reliance on trucking for freight transportation in the region and the need for higher levels of safety.

The existing section of highway, which will be bypassed by the proposed project, is the only non-controlled access section of Highway 104 between Truro and Amherst and is reputed to be one of the most dangerous sections of 100 series highway in the Province.

Average annual daily traffic (AADT) volumes for the existing stretch of highway have increased 21 percent over the five year period of 1985 to 1990 (see Figure 3-1). Tractor trailers comprised 16 percent of the yearly traffic in 1990 with daily rates exceeding 1000 units during the period of March through November. Fatal accidents for this section of the existing highway exceed the provincial average of 1.9 deaths per 100 million kilometres driven for two-lane uncontrolled highways by a factor of two for some sections.

The need to address this section of highway both in terms of meeting overall provincial highway policy, and in the need to provide a safer highway through or around this section of the Trans-Canada was apparent. A new route was selected in favour of upgrading the existing highway due to environmental, social and cost considerations as described in Section 2.1.

ACCIDENT RATES PER 100 MILLION Km (1986 - 1990)



1985	5250	5350	5910	5100	5100	-
1990	-	6590	-	7910	6530	9720

AVERAGE ANNUAL DAILY TRAFFIC



NOLAN, DAVIS
& ASSOCIATES

FIGURE 3-1
TRAFFIC & ACCIDENT DATA
FOR EXISTING HIGHWAY
(SOURCE - NSDOTC)

PART 4

OTHER METHODS FOR CARRYING OUT THE UNDERTAKING

4.0 OTHER METHODS FOR CARRYING OUT THE UNDERTAKING

Other methods for carrying out the undertaking include the possibility of using alternative routes or simply upgrading the existing highway to achieve the objectives described in the preceding section.

The route screening process described in Section 2.1 rejected the alternative of upgrading the existing route (with some modifications) on the grounds of environmental, social and financial criteria. Four route alternatives were examined in the screening study and led to the identification of the proposed Western alignment as the preferred option. The executive summary of the Screening Study is included as Appendix 1.

The methods proposed for the design and construction of the proposed highway conform to accepted Provincial Standards and respect the environmental sensitivities identified in this report.

PART 5

ALTERNATIVES TO THE UNDERTAKING



5.0 ALTERNATIVES TO THE UNDERTAKING

There are no viable alternatives to upgrading this section of Highway 104 to a controlled access highway other than to maintain the existing highway. This would commit the residents of the area and other users of the highway to increasing accident rates, traffic delays and impractical levels of maintenance.

Factors such as increased emphasis on rail transportation and use of public transportation to reduce demand on the highway system, and thus eliminate or forestall the need for upgrading it, are somewhat esoteric in the context of commitments already made for neighbouring sections of the Trans-Canada Highway in the Maritime Provinces.

At a detailed level, two alternative sections of the alignment were considered in response to concerns that were expressed to NSDOTC and/or identified in the course of this assessment. The first of these was a potential change in alignment in the Masstown/Glenholme area as shown in Figure 5-1. It was initially proposed by the West Colchester Rural Development Association (WCRDA) for the following reasons:

- 1) To relocate the highway further away from residences to reduce noise, pollution and property devaluation; and
- 2) To reduce the potential commercial development where the Department's proposal crosses the existing Highway 104 north of Glenholme by relocating the crossing point 1.6 kilometres further north.

The proposal was examined in detail by NSDOTC and it was decided to retain the proposed alignment because:

- 1) The WCRDA proposal would relocate the Highway 104 interchange an additional 1.6 kilometres north of Glenholme, which would have a negative impact on the attempt to preserve the Glenholme loop as a service area:

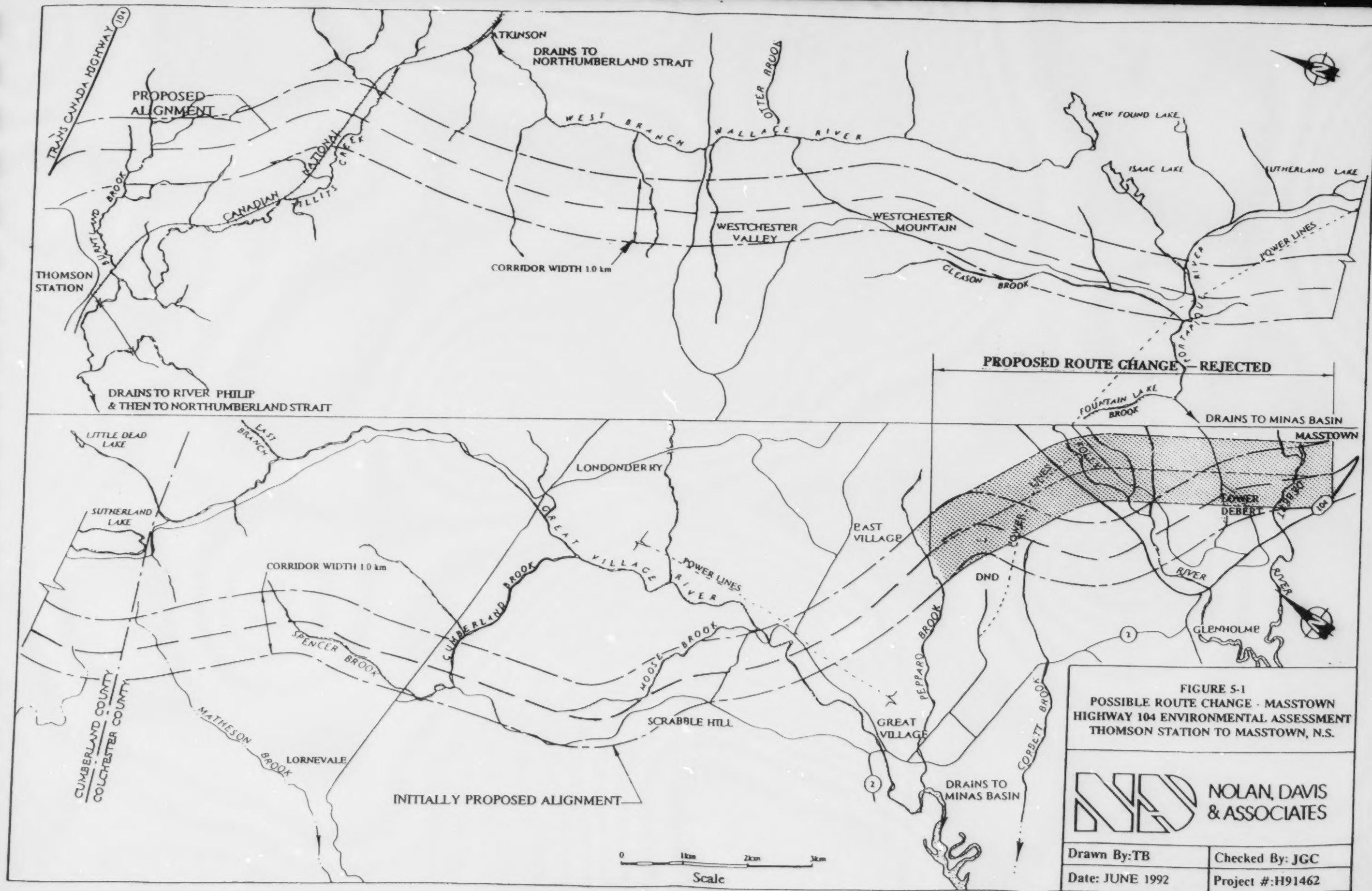
- 2) The WCRDA proposal passes through the middle of an "award of excellence" dairy farm on the Gray Road which would seriously disrupt its operation;.

The Glenholme area is currently an established service area for truckers, tourists and other users of the Trans Canada Highway. By providing convenient access to, and egress from this area from the proposed alignment, the existing facilities can be preserved and possibly enhanced to provide a major service area for this section of the highway as a whole. This will bring significant economic benefits to the Glenholme area and will reduce the potential environmental impact of development at neighbouring interchanges on the system compared to providing fragmented service facilities elsewhere.

The use of off-highway service loops providing a wide range of user needs is an established trend on new highway systems in North America and elsewhere.

The second detailed alternative is a 6.7 kilometres section west of Great Village shown in Figure 5-2. This was considered as a mitigative measure due to concerns over the impact that the originally proposed alignment might have on agricultural land and the crossing of the Great Village River. This alternative is described in Appendix 2 and is recommended as being preferable to the originally proposed alignment in this area, as described in the body of the report.





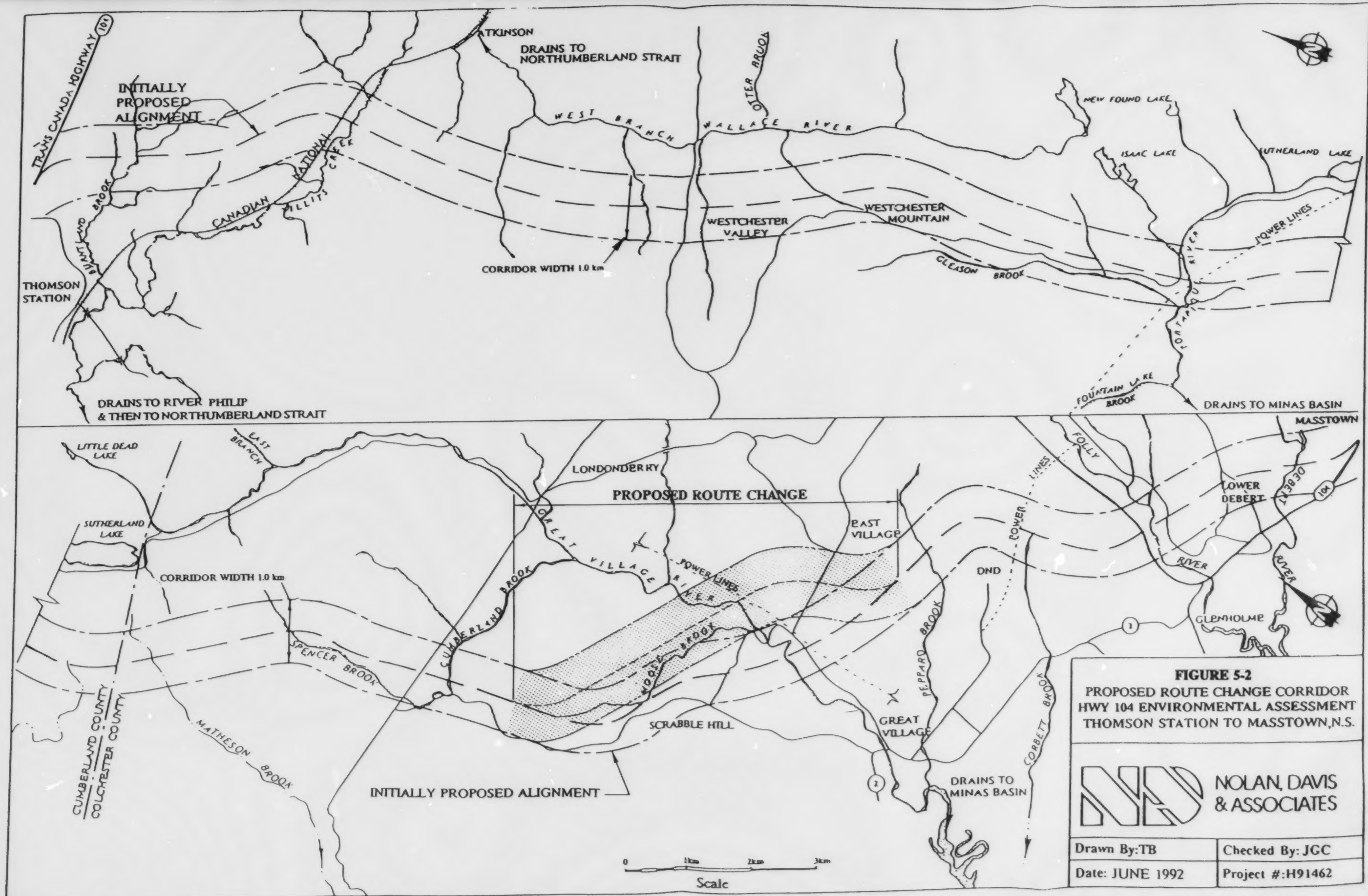


FIGURE 5-2
PROPOSED ROUTE CHANGE CORRIDOR
HWY 104 ENVIRONMENTAL ASSESSMENT
THOMSON STATION TO MASSTOWN, N.S.

NOLAN, DAVIS & ASSOCIATES

Drawn By: TB

Checked By: JGC

Date: JUNE 1992

Project #: H91462

PART 6

DESCRIPTION OF EXISTING ENVIRONMENT

6.0 DESCRIPTION OF EXISTING ENVIRONMENT

6.1 Introduction

A description of the existing environment was compiled from a review of available literature and data, communications with government agencies and other knowledgeable persons, and field studies conducted primarily in October and November, 1991. This overview of the study area provides a basis for determining which ecological components may be impacted by the undertaking. For the purposes of this assessment, the environment comprises both biophysical and socio-economic components in accordance with the definition of the environment provided in the Nova Scotia Environmental Protection Act.

6.2 Physical Landscape

6.2.1 Physiography

Mainland Nova Scotia is separated into nine physiographic regions. Within the study area three of these principal physiographic regions are represented (Figure 6-1); the Cobequid Highlands Massif (CHM), the Northumberland Coastal Lowlands and the Minas Lowlands.

6.2.1.1 Cobequid Highlands Massif (CHM)

The CHM is the mountainous region within the study area and forms a narrow plateau (approximately 14 to 16 kilometres wide) which extends in an east-west direction. The CHM is characterized by its rolling summit of relatively consistent elevation (230 metres), however, there are isolated knolls of higher elevations.

The prominence of the CHM is the result of the relative resistance of its igneous and metamorphic bedrock to erosion. The subsequent erosion of the CHM rocks over time produced the Northumberland and Minas Lowlands.

Landforms on the CHM are strongly bedrock controlled. The overburden (till) is typically stony, porous and contains a high percentage of locally derived clasts. Glaciofluvial deposits of sand and gravel generally occupy river valleys throughout this

region.

6.2.1.2 Northumberland Coastal Lowlands

The Northumberland Coastal Lowlands extend from the northern edge of the CHM in a northerly direction towards the Northumberland Strait. The lowlands generally slope downwards from the base of the CHM (elevation 100 metres) to sea level and are gently undulating to gently rolling.

Gently folded sedimentary bedrock underlies these lowlands which parallel the east-west direction of the CHM. The overburden is derived principally from the underlying sedimentary strata and ranges from moderately fine-grained to moderately coarse-grained. The tills in this region are typically dense and of low permeability.

6.2.1.3 Minas Lowlands

The Minas Lowlands extend from the southern edge of the CHM (elevation 125 metres) south towards Cobequid Bay and east towards the Colchester-Pictou County border (elevation 200 metres) in the study area. The dominant landform in this region is a gently undulating till plain.

The relative degree of resistance to erosion of the underlying Carboniferous and Triassic aged sedimentary bedrock accounts for the wide range of elevations found in the lowlands. The till units blanketing the lowland were principally derived from the underlying bedrock and are generally deep with moderately fine-grained to moderately coarse-grained textures. The tills typically are slightly stony and have a wide range of permabilities.

6.2.2 Geology

6.2.2.1 Bedrock Geology

The CHM is a structurally and stratigraphically complex narrow plateau which extends in an east-west direction across the study area. These rocks range from Hadrynian

to Middle Devonian age (900 to 374 million years) and are consist of igneous (plutonic/volcanic), metamorphic and sedimentary rocks (Donohoe and Wallace, 1982).

The igneous and metamorphic rocks comprising the CHM are generally very competent and have poorly developed fracture systems. Structurally formed sedimentary basins flank the northern and southern limits of the CHM. The subsequent erosion of the CHM rocks over time has provided sediments which have become consolidated to form bedrock of the Northumberland and Minas Lowlands.

The Cumberland Basin is located on the northern edge of the CHM and contains a complex succession of coarse to fine-grained alluvial to fluvial-lacustrine rocks. Similar types of bedrock are also found in the Minas-Shubenacadie sub-basin which borders the southern boundary of the CHM. Within the study area, these rocks are comprised primarily of thick sequences of clastic rocks (sedimentary rocks composed of fragments of pre-existing rocks such as siltstone, sandstone, conglomerate).

From existing information, the bedrock present along the proposed alignment has little likelihood of producing acid drainage. The inherent sulphide mineralization present in the geologic formations is typically observed in low percentages and is widely distributed throughout the host rocks.

The phenomena of acid drainage occurs when unbuffered sulphide minerals such as pyrite (iron pyrite, fools gold), chalcopyrite, etc. present in the bedrock become exposed to air and water. Under these conditions the above noted components react to produce sulphuric acid. As the sulphuric acid forms, it may chemically react with other minerals in the rock and dissolve naturally occurring heavy metals (ie. mercury, lead, zinc, arsenic) which may be transported via runoff to surface water bodies and/or groundwater supplies. The increased concentration of sulphuric acid can severely depress the pH of water, whereas, the presence of heavy metals can degrade the quality of aquatic habitats (fish kills) and potable groundwater supplies.

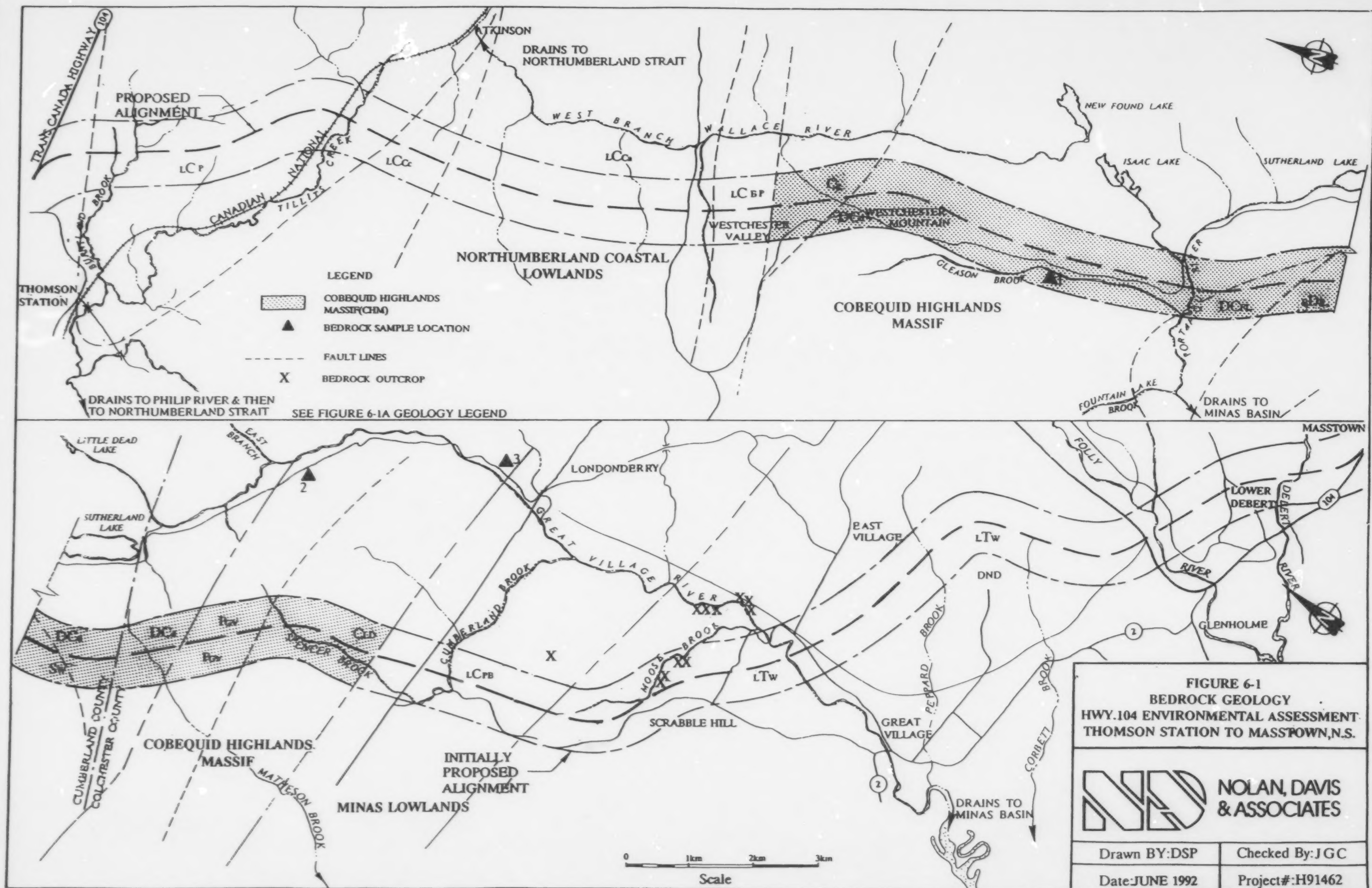
The NSDOE and Environment Canada have jointly prepared "Guidelines for Development on Slates in Nova Scotia" (April, 1991). These provide criteria for determining if a particular rock can be considered acid producing. If the total sulphide content exceeds 0.4 percent and the rock does not contain sufficient minerals such as calcium to neutralize or consume the acid, the rock is considered acid-producing and proper steps must be taken to reduce or eliminate acid production and heavy metal release. Although the guidelines specifically target slate bedrock (Halifax Formation), the guidelines are also applicable to other sulphide-bearing bedrock.

Bedrock units along the proposed alignment known to have naturally occurring pyritic/sulphide mineralization were identified as Devono-Carboniferous granitoid rocks (DC_g), Great Village gneiss (P_{gv}) and rocks of the Londonderry Formation (C_{LD}) (Figure 6-1). These rock types were sampled and submitted for percent total sulphide analysis. Results are presented in Table 6-1. All samples tested were below the 0.4 percent Total Sulphide limit set by the Nova Scotia Department of Environment and Environment Canada in "Guidelines for Development on Slates in Nova Scotia" (1991).

TABLE 6-1
Bedrock Samples Submitted for Total
Sulphide Analysis

Sample Number	Bedrock Type	Percent Total Sulphide	Maximum Acceptable Total Sulphide Concentrations
1	Granitic (DC_g)	0.067	0.4
2	Gneiss (P_{gv})	0.130	0.4
3	Quartzite (C_{LD})	0.027	0.4







6.2.2.2 Surficial Geology

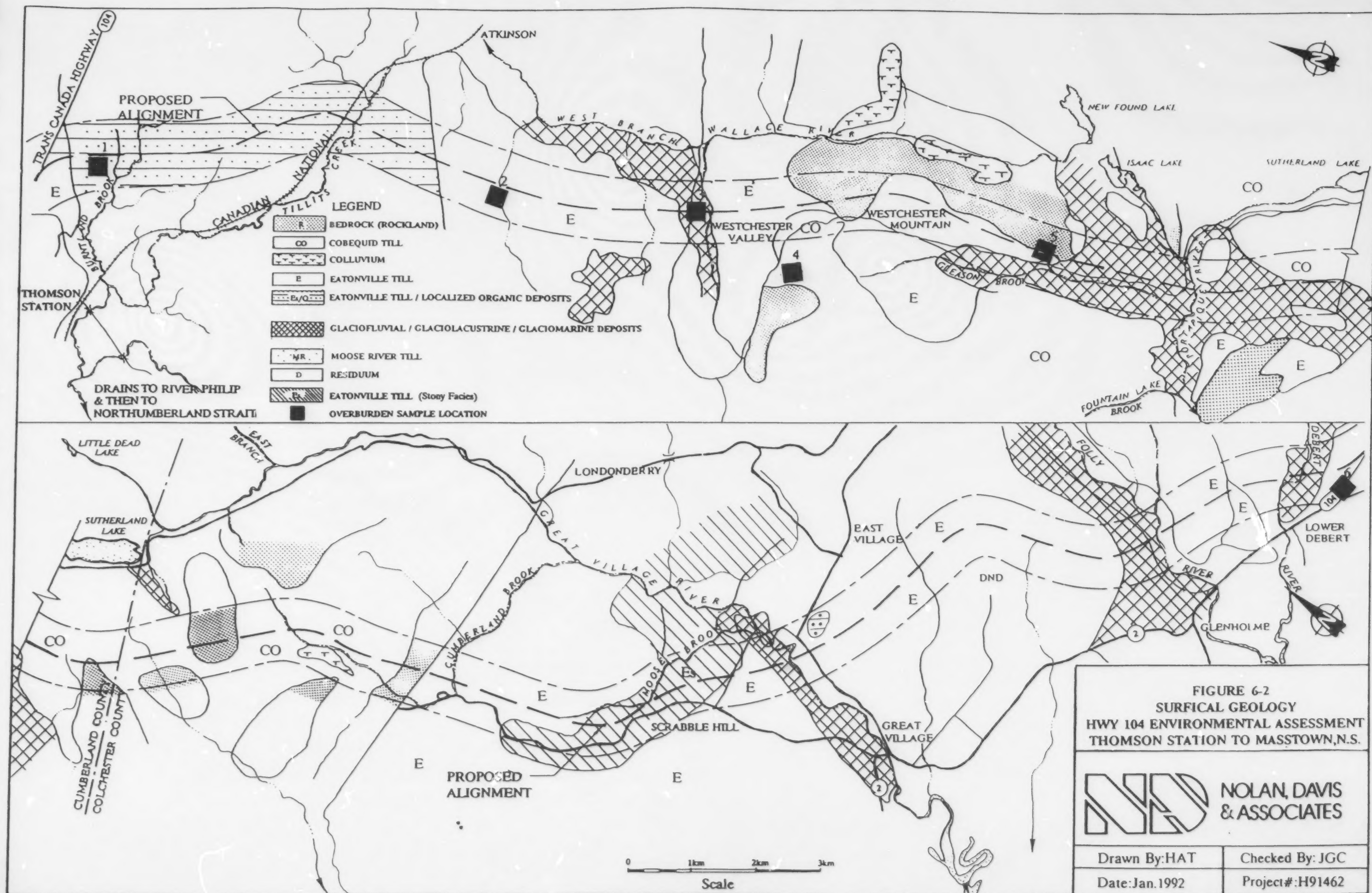
The surficial geology of the study area is somewhat complex. Documented evidence (Stea et al, 1988) indicates that this region of the province has been affected by at least four major glacier ice flows (phases). These four major ice phases are primarily responsible for the present day landscape appearance. Figure 6-2 identifies the major surficial geologic units which are expected to be encountered along the proposed alignment.

The predominant surficial material identified in the study area is till. Till is defined as an unsorted, non-stratified sediment deposited by glacial ice. A till's sediment content may range from clay to boulder sized particles.

During field reconnaissance, representative samples of soil parent material (till) were collected primarily from roadside exposures along the proposed alignment. These samples were examined, descriptions recorded and the locations noted on a base map. A comparison to existing surficial geologic and soils mapping was made. Existing mapping was found to be accurate. Six representative till samples were submitted for grain size determinations. Results are presented in Table 6-2.

The Eatonville Till is the most prolific surficial material present in the study area. This reddish-brown, sandy silt to silty sand clay rich till occurs extensively in the Cobequid Highlands along the proposed alignment. Thickness can be expected to range from less than three metres (Cobequid Highlands) to 30 metres (north and south of the Cobequid Highlands).

The Cobequid Till occurs primarily in the Cobequid Highlands and is greyish brown in colour. This till is classified as a very stony sand till which is typically composed of greater than 90 percent of rocks (igneous and metamorphic) which form the Cobequid Highlands. Thicknesses can be expected to range from less than one metre to five metres, however, localized greater thicknesses have been noted near the proposed alignment.



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TABLE 6-2**Till Sample Analyses**

Sample No.	Description	% Clay	% Silt	% Sand	% Gravel
1	Roadcut-Eatonville Till (stony facies)	3	15	51	31
2	Wetland - Eatonville Till	7	52	41	0
3	Roadcut - Glacio Fluvial/Lacustrine	3	15	46	35
4	Roadcut - Cobequid Till	3	9	41	47
5	Roadcut - Cobequid Till	1	5	36	58
6	Roadcut - Eatonville Till (sandy facies)	6	7	86	1

Glaciofluvial deposits (primarily sand and gravel), which represent potential sources of aggregate, are found along the entire length of the proposed alignment. These deposits generally occupy present day river valleys and can be expected to range from three to 20 metres in thickness, averaging less than seven metres. Many of these deposits have been, or are currently being, exploited for their aggregate.

6.3 Atmospheric Environment

6.3.1 Climate

The study area is located within a cool, humid, temperate climatic zone (Webb et al., 1991). This zone is influenced by prevailing westerly winds which cause many of the low-pressure systems moving across North America to pass over Atlantic Canada. The frequent passage of these systems, plus its maritime location, result in abundant precipitation within the study area (approximately 1200 millimetres per year).

The study area experiences a modified continental climate, which exhibits large variability in all seasons (Webb, et al., 1991). This variability results from the constant interaction of continental and maritime air masses, and because most of the weather systems originate in the interior, the continental influence often dominates the marine influence. The continental influence on the area produces a wide range in annual temperatures. Winters are typically cold with frequent snowfalls; springs are late, cool and cloudy; summers are warm and relatively humid. In general, rainfall is greatest during the fall months. The prevailing winds are westerly and northwesterly in the winter months and south to southwesterly during the summer months (Whiteside et al., 1945).

The oceanic influence tends to moderate the climate, thereby reducing the temperature range in coastal areas; resulting in milder winters, cooler summers, and longer frost-free periods than in the interior (Webb et al., 1991). The Northumberland Shore area is an exception, because the waters of the Northumberland Strait are typically warmer, tending to keep air temperatures warmer in summer and into the fall. However, in winter, the ice-covered strait has little influence in moderating air temperatures and also delays

spring warming.

The study area can be subdivided into three general climatic regions as shown in Figure 6-3: the Bay of Fundy/Minas Basin Lowlands (southerly section of route); the Cobequid Uplands (middle, highland section of route); and the Northumberland Lowlands/Cumberland Plain (northerly section of route). These climate zones apply equally to the proposed route as to the existing Highway 104 alignment. Thus no significant differences in climate for the existing and new routes is to be expected. The impact of climate on safety is discussed in Section 7.4.4.

The climatic data for Atmospheric Environment Service (AES) stations at Nappan, Oxford, Pugwash, Tatamagouche and Stellarton-Lourdes in Pictou County are representative of the Northumberland Lowlands/Cumberland Plain; data for AES stations at Parrsboro, Debert Airport and Truro are representative of the Bay of Fundy/Minas Basin Lowlands climatic region (Webb *et al.*, 1991). Although no long term climatic data are available for the Cobequid Uplands, it might be assumed that because of their elevation, the climate would be similar to that of the Horton Highlands (Trafalgar Station).

6.3.2 Meteorology

6.3.2.1 Temperature and Precipitation

Basic meteorological data were obtained from the Atmospheric Environment Service (Environment Canada, 1951-1980 Climate Normals and 1986-1990 data for current stations). The mean annual data for 11 meteorological stations in this region of Nova Scotia, plus one station in Sackville, New Brunswick, are provided in Table 6-3. The station locations are shown in Figure 6-3.

The Bay of Fundy/Minas Basin climatic region is characterized by cool summers, mild winters, frequent fog (particularly in spring and fall), and moderate precipitation. Coastal areas are impacted by westerly and northwesterly winds in the winter and generally experience stronger winds than points inland (Nowland and MacDougall,

TABLE 6-3

Climatology Summary (1951-1980 Data)

Station	Orford (13)	Debert (44)	Truro (40)	Tatamagouche (8)	Nappan (20)	River Hebert (15)	Parrsboro (18)	Trafalgar (152)	Hopewell (152)	Stellarton (11)	Pugwash (5)	Sackville N.B. (24)
Elevation (m)												
Temperature (°C)												
- annual mean	5.6	5.7	5.3	6.2	5.6	5.4	5.6	4.9	n.a.	6.3	6.3	w
- maximum mean daily	25.2 (Jul)	24.3 (Jul)	23.7 (Jul)	19.2 (Jul)	23.7 (Jul)	24.3 (Jul)	22.9 (Jul)	23.4 (Jul)	n.a.	24.5 (Jul)	24.5 (Jul)	23.2 (Jul)
- minimum mean daily	-14.1 (Feb)	-12.2 (Feb)	-13.1 (Feb)	-11.8 (Feb)	-11.6 (Feb)	-13.4 (Feb)	-11.6 (Feb)	-13.9 (Feb)	n.a.	-11.3 (Feb)	-11.8 (Feb)	-11.3 (Feb)
- extreme maximum	36.1 (Aug)	35.0 (Aug)	32.8 (Aug)	35.0 (Jun)	34.4 (Aug)	35.0 (Aug)	33.3 (Jul)	34.4 (Jul)	n.a.	35.0 (Aug)	33.9 (Aug)	36.1 (Aug)
- extreme minimum	-36.7 (Feb)	-33.3 (Feb)	-34.4 (Feb)	-31.1 (Feb)	-37.2 (Feb)	-37.3 (Jan)	-35.6 (Jan)	-35.0 (Feb)	n.a.	-39.4 (Feb)	-28.9 (Jan)	-33.3 (Feb)
Precipitation (mm)												
- annual total	1108.4	1296.2	1138.7	1058.1	1106.8	1223.4	1222.8	1442.5	1219.5	1060.5	973.7	1135.3
- rainfall	852.9	1077.6	914.3	813.4	855.2	962.8	1038.4	1152.7	953.3	859.8	796.8	914.6
- snowfall (cm)	254.6	208.0	246.7	244.1	246.1	261.3	183.1	284.2	266.0	200.9	214.1	218.0
- maximum mean monthly	120.1 (Dec)	148.4 (Nov)	133.7 (Dec)	116.1 (Nov)	118.7 (Dec)	128.4 (Jan)	130.6 (Dec)	164.0 (Dec)	137.7 (Nov)	123.6 (Nov)	106.9 (Jan)	117.1 (Nov)
- minimum mean monthly	73.5 (Jun)	82.5 (Jul)	60.0 (Jun)	71.9 (May)	75.3 (Apr)	74.8 (Jun)	85.1 (Jun)	91.9 (Jun)	79.9 (Apr)	70.3 (Jun)	65.1 (Jul)	77.9 (Apr)
- greatest rainfall in 24 hrs	98.3 (Jan)	92.5 (Jan)	100.8 (Aug)	130.8 (Aug)	153.7 (Sep)	98.6 (Jun)	152.7 (Oct)	148.6 (Sep)	193.8 (Aug)	165.6 (Aug)	79.5 (Oct)	93.5 (Oct)
- greatest snowfall (cm) in 24 hrs	45.7 (Jan)	39.4 (Mar)	38.1 (Dec)	29.7 (Feb)	55.9 (Jan)	41.7 (Jan)	45.7 (Feb)	53.3 (Dec)	36.0 (Feb)	40.6 (Mar)	32.5 (Feb)	45.7 (Jan)
- days with rain	119.0	121.0	123.0	100.0	111.0	112.0	106.0	112.0	125.0	120.0	103.0	105.0
- days with snow	47.0	63.0	60.0	28.0	37.0	45.0	27.0	54.0	49.0	43.0	28.0	33.0
- days with precipitation	153.0	173.0	164.0	126.0	141.0	148.0	128.0	152.0	166.0	155.0	126.0	134.0

1973). Within this climatic region, total mean annual precipitation ranges from a low of 1139 millimetres at Truro to 1296 millimetres at Debert (Table 6-3). Average snowfall amounts range from 183 centimetres at Parrsboro to 247 centimetres at Truro. The monthly average of mean daily maximum temperature ranges from a low of 22.9° C at Parrsboro to 24.3° C at Debert (July); whereas the monthly average of daily minimum temperature ranges from a low of -13.1° C at Truro to -11.6° C at Parrsboro (February).

The Northumberland Shore/Cumberland Basin climatic region is characterized by cool summers, mild winters, coastal fog (particularly in spring and fall), and moderate precipitation. Coastal fogs are generally less frequent, and total annual precipitation is lower than along the Fundy coast. Coastal areas are affected by westerly and northwesterly winds in the winter and generally experience stronger winds than points inland. Northwesterlies in the spring are frequently responsible for cooler temperatures and delayed plant growth along the Northumberland shore, compared to more inland areas (Nowland and MacDougall, 1973). Within this climatic region, total mean annual precipitation ranges from a low of 974 millimetres at Pugwash to a high of 1108 metres at Oxford (Table 6-3). Average snowfall amounts range from 201 centimetres at Stellarton to 255 centimetres at Oxford. The monthly average of mean daily maximum temperature ranges from a low of 19.2° C at Tatamagouche to 25.2° C at Oxford (July); whereas the monthly average of daily minimum temperature ranges from a low of -14.1° C at Oxford to -11.3° C at Stellarton (February).

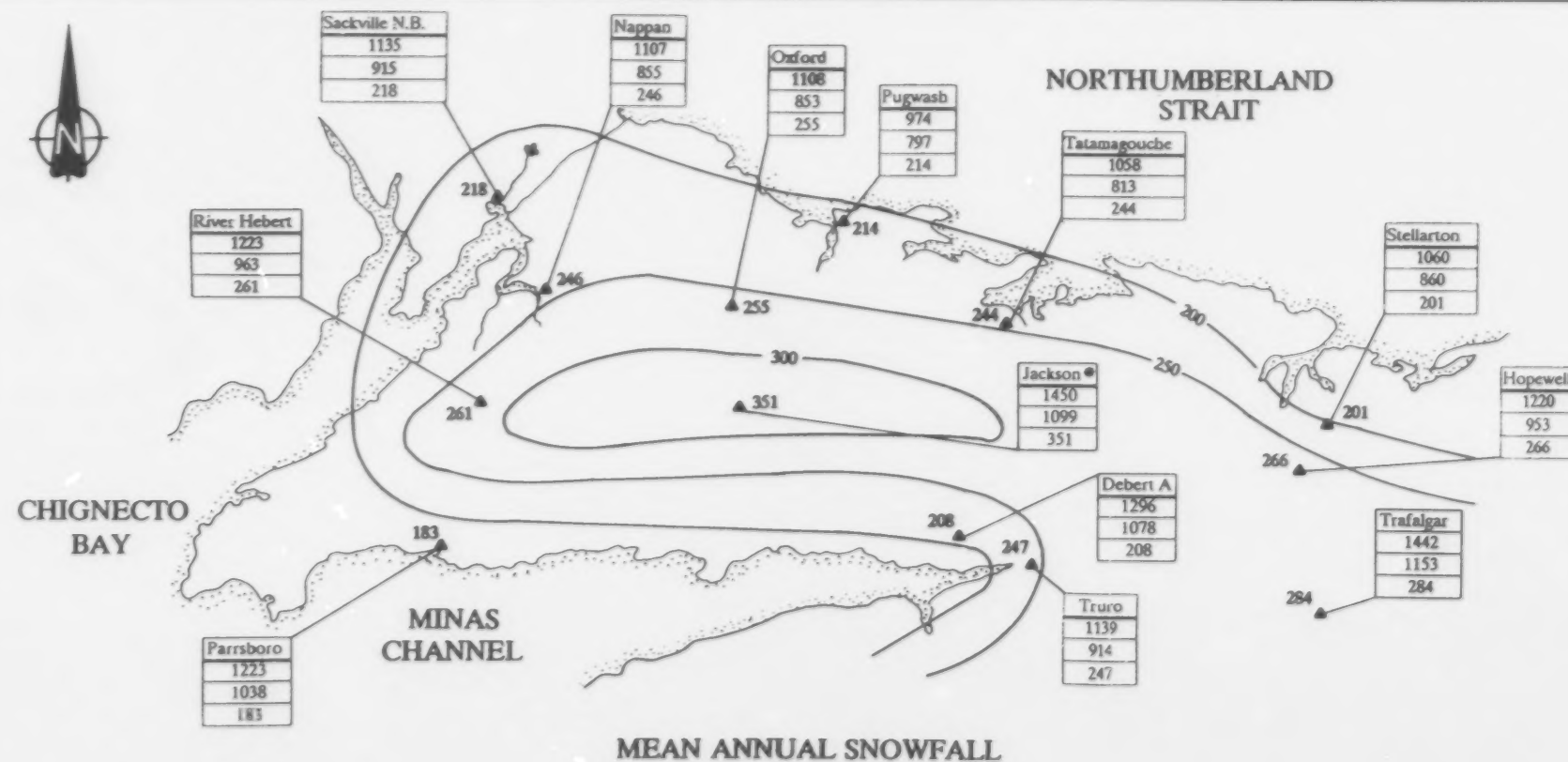
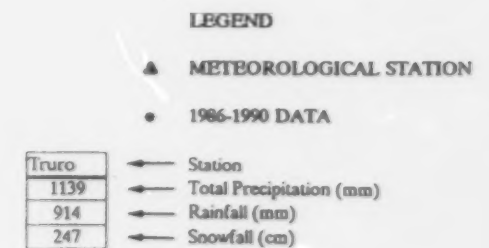
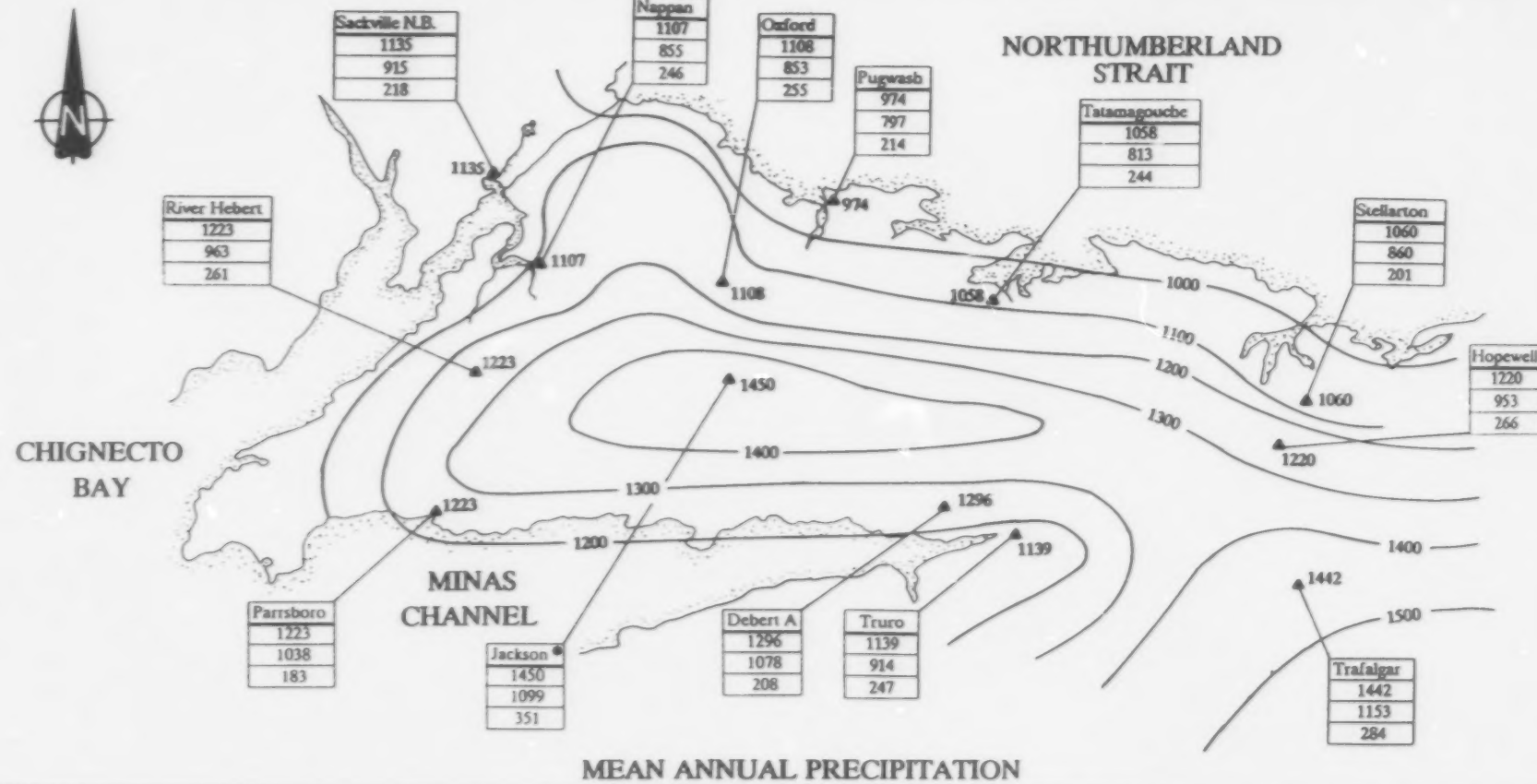
As noted above, there is no long term data for the Cobequid Uplands climatic region. Assuming that the data from the Horton Highlands are generally similar to the Cobequid Upland region, data from the station at Trafalgar (elevation 152 metres) might be considered to be representative of the Cobequid Uplands region. At Trafalgar, total mean annual precipitation is 1442 millimetres, with an average snowfall amount of 284 centimetres (Table 6-3). The average mean daily maximum temperature is 23.4° C in July; whereas in February the average daily minimum temperature is -13.9° C.

Climatic data have been collected at the Cobequid Fish Culture Station (Jackson Station) since 1980. Although not entirely representative of typical climatic conditions which might be expected at elevation in the Cobequids (Jackson Station is located at 92 metres A.S.L.), these data are generally representative of interior locations in northern Nova Scotia. At Jackson, total mean (1987 to 1990) annual precipitation is 1450 millimetres, with an average snowfall of 351 centimetres. These data indicate that this interior region of northern Nova Scotia typically receives higher total annual precipitation and snowfall compared to coastal areas.

The preceding data therefore suggests that the Cobequid Uplands region receives a higher total annual precipitation and snowfall than other portions of northern Nova Scotia. This is supported in a study conducted in 1978, Vaughan and Somers (1980), reported that regional mean (based upon 1967 to 1976 data) precipitation trends for Cumberland County ranged from a high of approximately 1400 millimetres in the Cobequid Mountains, to a low of about 1000 millimetres along the Northumberland coast. In an inter-station comparison of total precipitation collected over the duration of the study (1978), Vaughan and Somers (1980) reported higher annual precipitation amounts of 1320 millimetres at Sugarloaf Mountain (elevation 317 metres) and 1230 millimetres at Westchester (elevation 281 metres), compared to 968 millimetres at Oxford (elevation 13 metres), 972 millimetres at Nappan (elevation 20 metres) and 915 millimetres at River Hebert (elevation 15 metres).

Figure 6-3 illustrates the regional trends in mean (1951-1980 data) annual precipitation and snowfall for northern Nova Scotia. From this figure, it is apparent that precipitation, both as rainfall and snowfall, decreases with distance from the highlands toward adjacent bodies of water, dropping the most in the direction of Northumberland Strait.

The lack of meteorological stations at elevation in the Cobequid Mountains region, and the probability that there are local variations in the rainfall/snowfall patterns,



SCALE 1: 1 000 000

FIGURE 6.3
ISOHYETAL MAP OF MEAN ANNUAL
PRECIPITATION AND SNOWFALL
FROM 1951-1980
HWY.104 ENVIRONMENTAL ASSESSMENT
THOMSON STATION TO MASSTOWN, N.S.

NOLAN, DAVIS & ASSOCIATES

Drafted By N.P.	Checked By R.W.
Dated Aug. 1991	Project No. H91462

both with location and elevation, make it difficult to define the probable micro-climate at elevation in the Cobequids. While it is difficult to predict the potential impact that the construction of a highway will have on the micro-climate of the higher elevation areas, it is most probable that there will be negligible impact.

6.3.2.2 Winds

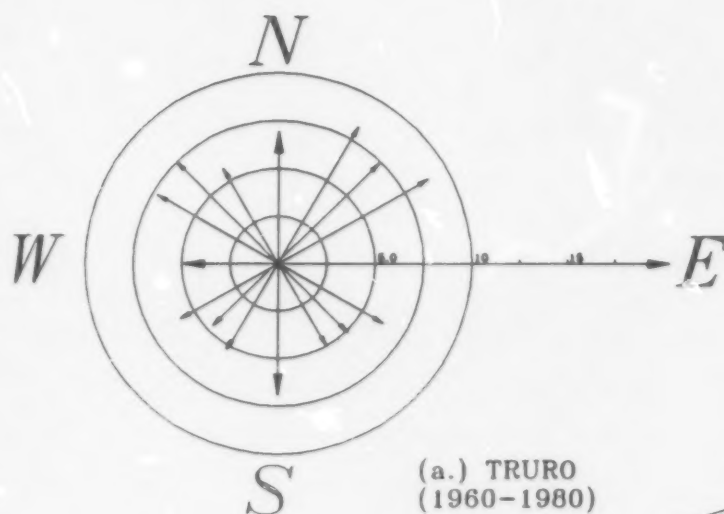
Figure 6-4 presents wind roses for Truro, Debert and Amherst weather stations. Winds in the area are predominantly from the south to west compass quadrant, particularly during the construction season. Northerly and easterly winds dominate during storm events while winter winds are often from the north and west quadrant. South-east winds show the lowest frequency of occurrence.

Table 6-4 provides wind data for the above three stations. Average annual winds range from 13.8 to 17.7 kilometres per hour depending primarily on local geographical features. Winds are strongest during the winter months and weakest during the summer months, when they still average 78 percent of winter velocities. Maximums reach 93 kilometres per hour at Truro and 80 kilometres per hour at Debert while gusts of 134 kilometres per hour have been attained at Truro.

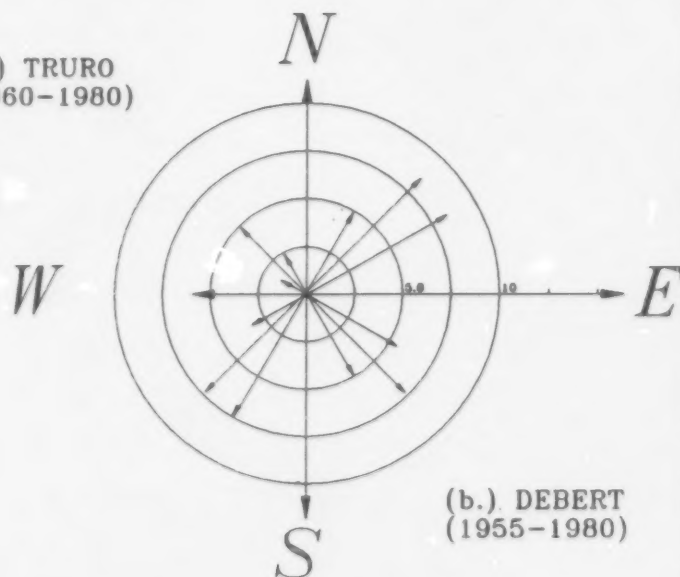
Wind speeds do not differ greatly over the region. In the absence of specific wind data for the Cobequid Highlands, it can be stated that winds in that area will tend to be similar in direction but higher in velocity, on average, than the data shown.

6.3.3 Air Quality

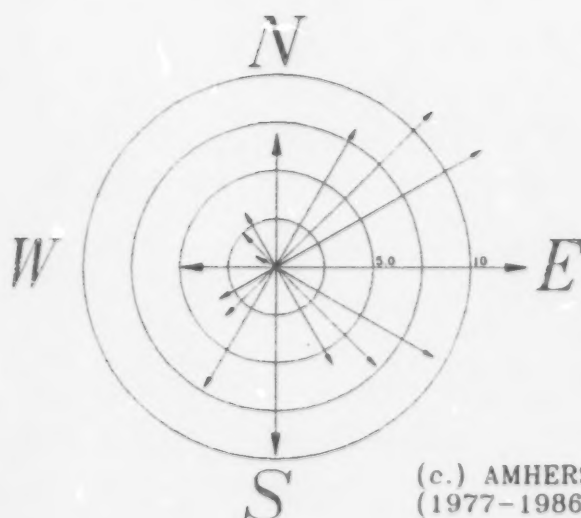
The existing air quality in the study area is influenced by natural conditions, local point sources, distant point sources and mobile sources. Larger, local point sources of emissions include a lumber mill (Colchester Station), an asphalt plant (Debert) and an aggregate operation (Folly Mountain) which influence an area around each installation. Other local air quality influences include traffic related emissions or intermittent agricultural/industrial operation or equipment sources. These sources do not dominate



(a.) TRURO
(1960-1980)



(b.) DEBERT
(1955-1980)



(c.) AMHERST
(1977-1986)

NOTE:

FREQUENCY OF OCCURANCE REFLECTED
IN LENGTH OF VECTOR.



**NOLAN, DAVIS
& ASSOCIATES**

**FIGURE 6-4
WIND ROSES FOR
CUMBERLAND/COLCHESTER
COUNTY STATIONS
NOVA SCOTIA**

JUNE, 1992

H01462

regional emission loadings.

TABLE 6-4

**Wind Speed Data
Northern Nova Scotia**

Month	Location					
	Truro		Debert		Amherst	
	Mean ¹	Max ²	Gust ³	Mean	Max	Mean
Jan	15.1	93	115	17.0	72	19.3
Feb	15.4	71	134	16.3	72	18.6
Mar	16.0	64	94	19.3	74	19.4
Apr	14.9	61	84	15.7	51	18.4
May	14.1	61	89	14.9	48	17.6
Jun	12.8	48	94	14.9	56	17.5
Jul	11.6	48	122	12.3	45	17.0
Aug	12.0	58	76	11.9	64	15.2
Sep	11.6	51	81	13.5	72	16.2
Oct	13.1	64	107	14.1	55	17.0
Nov	14.0	68	108	16.4	77	17.4
Dec	14.8	69	108	16.2	80	18.4
Ave	13.8	93	134	15.1	80	17.7

¹ Mean - Mean Wind Speed, km per hour

² Max - Maximum hourly speed, km.

³ Gust - Maximum gust speed, km.

More distant air quality influences include contributions from the industrial complexes in the Sydney and New Glasgow areas as well as from Central Canada and the New England states.

The National Air Pollution Surveillance (NAPS) network has been established to monitor air pollution levels in Canada. Not all pollutants are measured at each site, however, there are five sites in metro Halifax, two in Sydney, N.S. and one each in Saint John, N.B., St. John's, Nfld., Charlottetown, P.E.I., Glace Bay, N.S. and Fredericton, N.B.

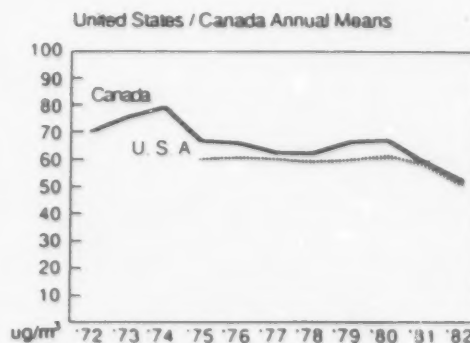
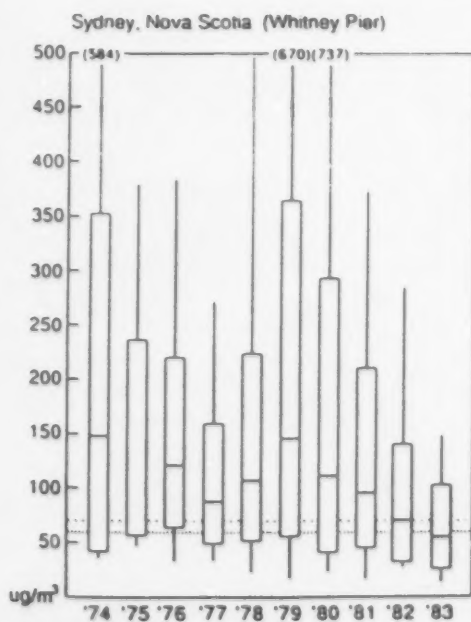
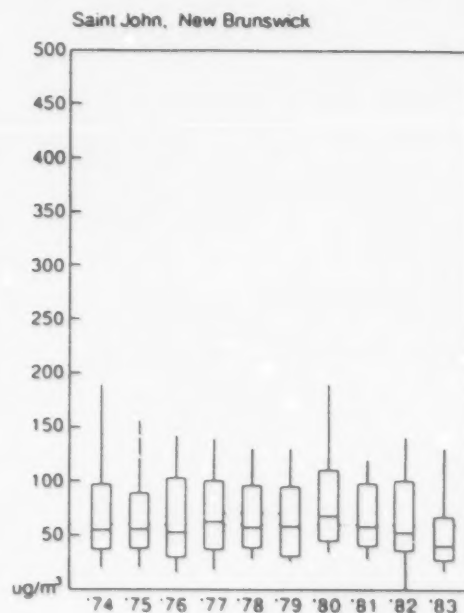
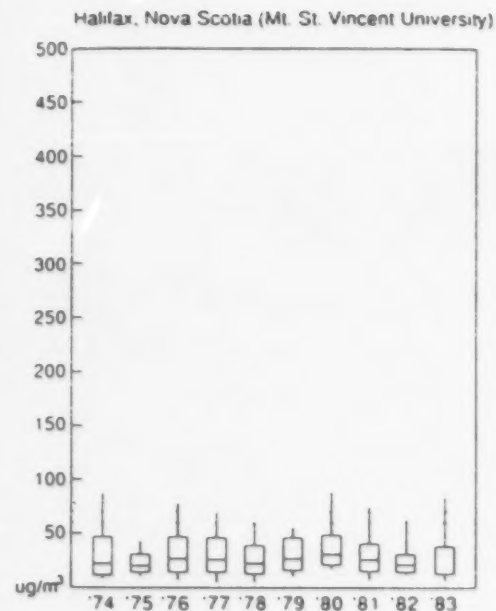
As a result of the complex nature of the monitoring equipment, its expense and maintenance requirements, surveillance stations are usually located near urban centers or point emission sources and, therefore, at some distance from the Study Area. Data from the Atlantic Province stations as well as from elsewhere on the continent are used to present information on the existing air quality in the study area.

6.3.3.1 Total Suspended Particulates

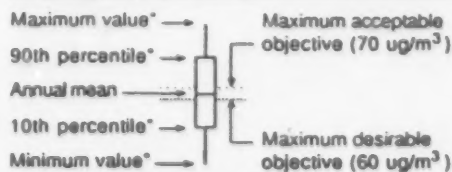
Total suspended particulates (TSP) describes solid or liquid particles which tend to stay suspended in the air and can be easily respired into the lungs. Particulates are the most commonly observed air pollution, resulting in visibility reduction, soiling and respiratory irritation. Point sources for TSP in Nova Scotia include thermal generation plants, pulp and paper mills and other industrial operations. Environment Canada has estimated that out of 780,000 tonnes of TSP emissions generated in Nova Scotia in 1980, 55 percent was dust from unpaved roads, 35 percent resulted from construction sites and 3.5 percent was dust from paved roads. Wood fuel burning, slash burning, quarrying operations, agriculture and asphalt production resulted in an estimated 1.0, 0.8, 0.5, 0.7 percent and 0.4 percent respectively.

TSP levels have decreased on the continent since 1974 and averages have remained relatively constant in recent years, below the 60 microgram per cubic metre (mcm) "maximum desirable objective" and the 120 mcm "acceptable limit" for a 24 hour period as set by regulatory authorities. Figure 6-5 reproduced from Eaton et. al., provides suspended particulate matter data for several locations in Nova Scotia as well as information on Canadian and U.S. means. Results in metro Halifax were similar in 1989 with the Technical University of Nova Scotia site registering an annual geometric mean of 35 mcm.

SUSPENDED PARTICULATE MATTER



LEGEND:



* Values represent 24 hour averages



**NOLAN, DAVIS
& ASSOCIATES**

FIGURE 6-5
AMBIENT AIR MONITORING TRENDS FOR
TOTAL SUSPENDED PARTICULATES(TSP)
IN ATLANTIC REGION CITIES
(1974-1983)

Charlottetown, during the same year had an annual geometric mean of 22 mcm. By comparison, 1985 annual means at Toronto, Montreal and Windsor stations were 87, 100 and 73 mcm respectively.

Localized readings adjacent to industrial facilities and roadways can be significantly higher. Sampling was conducted for four days in June, 1991 at Alma and Greenhill, Nova Scotia and found a range in TSP from 13.2 to 95.6 mcm, with the higher concentrations attributed to greater traffic movement during weekdays during a particularly dry season. The study area along the route is almost exclusively pristine, undeveloped or rural, low intensity, farm area. Because adequately generic information is available for particulate levels under these circumstances, detailed particulate measurements and surveys were not undertaken as part of this assessment. However specific studies are proposed to be conducted during the design and construction phases (see Section 10.3).

Existing particulates levels in the study area will be in the range of 15 to 35 mcm where not influenced by commercial or farm activity. Levels adjacent to unpaved roads or worked farmland will range up to 100 mcm for short time durations depending on local climate conditions.

6.3.3.2 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs cause concern because of their indicated carcinogenicity. PAHs are created by smelting operations and motor vehicles and are generated in large quantities by wood combustion. PAH levels in Truro and Lower Sackville, N.S. were found, in a 1985 study, to range between 0.1 and 30 nanograms per cubic metre (ncm). These levels were interpreted as being well below those which would have a public health impact. Levels in the study area would be expected to fall in the lower end of the range.

6.3.3.3 Sulphur Dioxide

Sulphur dioxide originates from several regional sources such as thermal power plants. However, 75 to 80 percent of the sulphur deposited in the region originates in

Central Canada and the northeastern U.S. Thermal stations produce 87 percent of the region's own sulphur dioxide production while fuel combustion, including motor vehicles, produce 90 percent of the remaining 13 percent. Power stations can influence sulphur dioxide levels within 50 kilometres and therefore may impact the study area. Maximum acceptable annual means have been set at 20 parts per billion (ppb) while maximum desirable limits are ten ppb. Between 1974 and 1983, readings at Mt. St. Vincent University in Halifax ranged up to 0.5 ppb, averaging less than 0.1 ppb. In 1989, sulphur dioxide levels in Sydney, Nova Scotia averaged two ppb, while in Charlottetown and Saint John, yearly averages of two and seven ppb were recorded. Yearly results in Saskatoon, Edmonton and Vancouver were less than one ppb, three ppb and four to eight ppb respectively. Annual mean levels for the study area are likely to be in the two to four ppb range.

6.3.3.4 Nitrogen Dioxide

Gasoline combustion is the largest single source of nitrogen dioxide generation in the Atlantic Region, followed by diesel engines, industrial fuel and power plant combustion, fuel wood burning and residential and commercial fuel combustion. Point sources include thermal plants, oil refineries and pulp mills. In 1980, Nova Scotia produced an estimated 48,000 tonnes of nitrogen dioxide emissions. Oxides of nitrogen can be carried thousands of kilometres from their point of emission.

The "annual maximum acceptable" limit for nitrogen dioxide is 50 ppb while the "maximum desirable limit" is 30 ppb. Readings at Shearwater ranged up to 90 ppb between 1974 and 1983, averaging well below 10 ppb for that period. Readings in downtown Halifax averaged up to 40 ppb during the early 1980's but annual means are generally less than 30 ppb. Annual means for stations in Canada and the U.S.A. were around 25 ppb during the same period, slowly dropping over the years. Annual averages in the study area would be expected to be in the 10 to 20 ppb range.

6.3.3.5 Carbon Monoxide

In 1980, 77 percent of the carbon monoxide produced in Nova Scotia was estimated to have come from gasoline powered vehicles. Other sources include burning of slash and fuel wood, on-highway and off-highway gasoline use and diesel fuel combustion. Point sources include oil refineries, thermal plants and pulp mills. Annual means for carbon monoxide declined during 1974 to 1978 but have remained more constant since that time. Target levels are expressed in terms of short term exposures with the "maximum desirable" eight hour limit being five ppm. Test results in downtown Halifax ranged up to nine ppm between 1977 and 1983, averaging less than two ppm for the period. The annual mean in downtown Halifax in 1989 was one ppm, while in Toronto it was as high as 2.4 ppm. Annual average for Saskatoon was 0.5 ppm in 1989. Canadian annual means for carbon monoxide concentrations in urban centers averaged about 1.6 ppm between 1977 and 1981. The annual mean for the study area would be expected to be less than 0.5 ppm.

6.3.3.6 Ozone

Ozone forms as a secondary pollutant resulting from photochemical reaction of hydrocarbons, nitrogen oxides and sunlight. Much of the ozone concentration level in Eastern Canada is thought to result from long range transport from large urban areas. Local hydrocarbon precursors contributing to ozone formation are fuels lost from vehicles and refineries, paint and solvent use and wood combustion. The target "Maximum acceptable annual mean" for oxidants, including ozone, is 15 ppb, however this level was being exceeded until the late 1970's nationally in the USA and is exceeded in urban areas in Canada. Annual averages at Shearwater and Halifax in 1989 were 27 and 18 ppb respectively. Annual averages in Ontario and Quebec in the same year ranged from ten to 29 ppb and 13 to 19 ppb respectively. Average growing season ozone concentrations, in 1987, at Dartmouth, Kejimikujik (Nova Scotia), Simcoe (Ontario), Saskatoon, Birch Mountain (Alberta), Kelowna and Abbotsford (B.C.) were 37, 31 49, 25, 36, 36 and 33 ppb respectively. The annual mean for the study area would be expected to be between 15 and 25 ppb.

6.3.4 Sound Levels

Existing sound levels in the study area are dependent on general activities in the vicinity. Sound levels are attenuated by distance, geographic and surface features.

6.3.4.1 Background

Sound is a sensation produced in hearing receptors as the result of waves or vibrations caused in the surrounding air by a disturbance. These sound waves are a compression wave which radiates from the source in much the same manner as a balloon expands as a gas is introduced. Since the disturbance is being distributed over a much wider radial surface as it travels from the source, sound level decreases with distance. Different vibration frequencies create different pitches of sound.

The minute variations in air pressure which result in sound are measured by sound level meters which are calibrated to describe those levels in decibels (dB). Weighting networks are built into meters to result in different responses to portions of the sound frequency spectrum received. The "A" weighting network most closely corresponds to the range of human hearing and is therefore used in most sound impact assessment work.

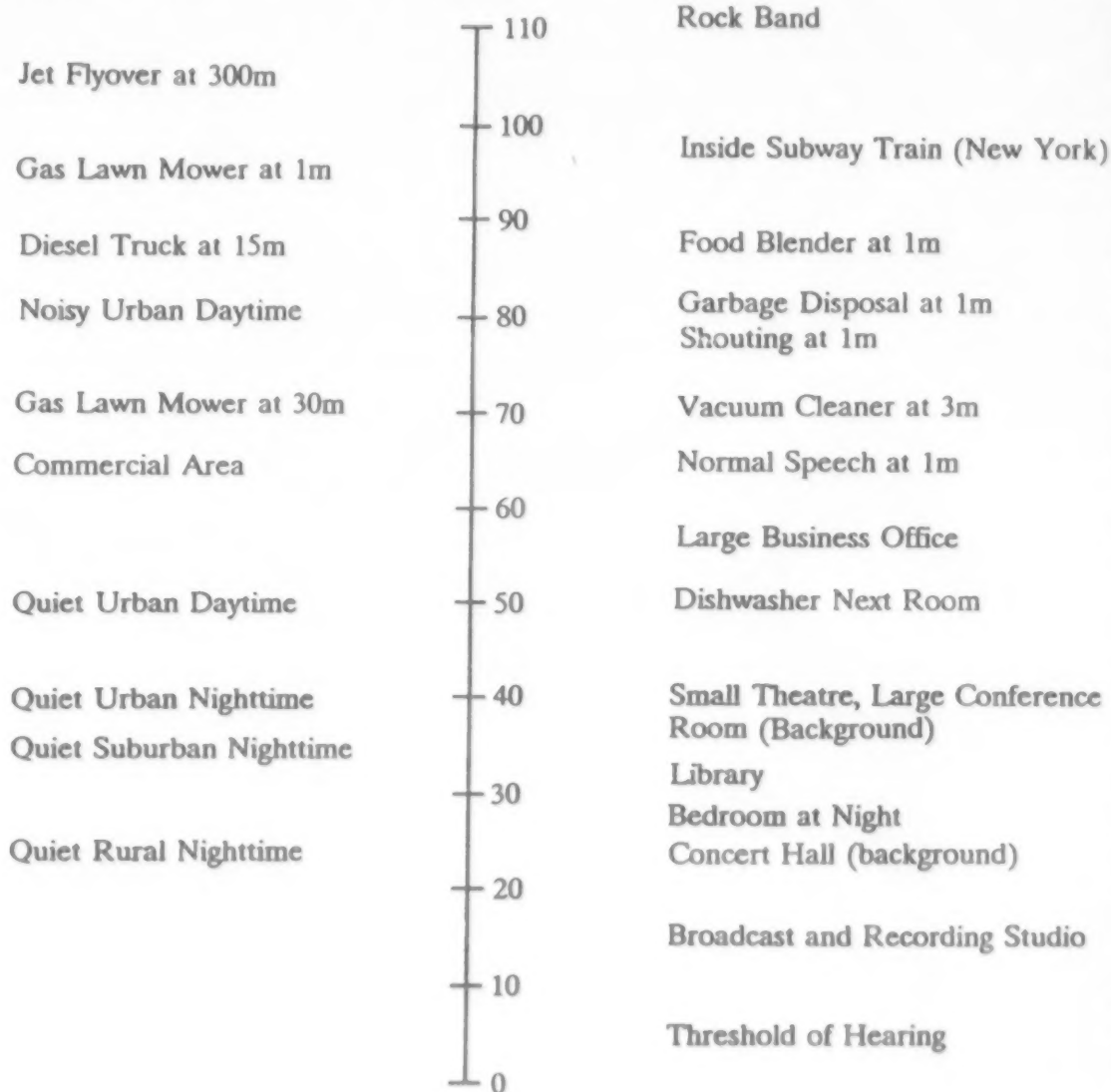
Figure 6-6 relates various dBA noise levels to common hearing experiences. Extremely low levels of sound are in the 20 to 35 dBA range while sounds causing immediate and noticeable disturbance start at 70 to 80 dBA. A quiet location such as a library or inactive residential area will register a sound level of approximately 35 dBA. A tractor trailer passing by at a distance of 15 metres will create a 90 dBA reading, similar to that of a blender at one metre.

Several different sound level parameters can be used to characterize a situation. Intermittent sound is described in terms of peak or maximum dBA level. For impact assessments, average levels have proven useful in gauging reaction to existing and changing sound levels. L_{eq} is such an average. It is a descriptor which averages the noise energy received over a time period and describes it as the average noise level which would

COMMON OUTDOOR NOISE LEVELS

NOISE LEVEL (dBA)

COMMON INDOOR NOISE LEVELS



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FIGURE 6-6
COMMON INDOOR
AND OUTDOOR NOISE LEVELS

have to exist over the same period of time in order to produce the same total acoustic energy at the receiver. Noise is defined as unwanted sound.

6.3.4.2 Baseline Sound Level Monitoring

To establish existing conditions for the purpose of this study, sound levels were monitored at ten points along the proposed alignment of the roadway. These locations were chosen at accessible points on the right-of-way. Two of the locations assessed conditions adjacent to the existing Highway 104 while the remainder tested conditions adjacent to existing residences or other points at intersections along the proposed route. Sound levels were recorded using a portable, battery-powered sound level meter (model-Bruel & Kjaer, 2225). All measurements were recorded at the Equivalent Continuous Level over a fixed period of sixty seconds.

Test locations and results are presented in Figure 6-7. Site conditions for all readings ranged from clear to high overcast with calm to very low winds. Ambient temperatures ranged from +2° C to +5° C.

Location 1 was at the extreme west end of the alignment, where the proposed roadway meets the existing Highway 104 at Thomson Station, while Location 8 was adjacent to the existing highway, where the right-of-way intersects Highway 104 north of Glenholme. Noise levels due to roadway traffic produced L_{eq} average readings of 67 and 68 dBA respectively at a distance of approximately 20 metres from the centerline of the near lane. Maximum levels were 84 and 97 dBA.

The remainder of the locations were typically rural settings where sound levels were dominated by occasional light duty vehicle traffic and rural industrial noises such as aircraft, hammering (distant), chain saws (nearby), trains and construction. Table 6-5 presents L_{eq} results for each location, a maximum sound level reading (where applicable) and a general description of local sound generating sources. Readings were taken at the edge of the right-of-way at these locations.

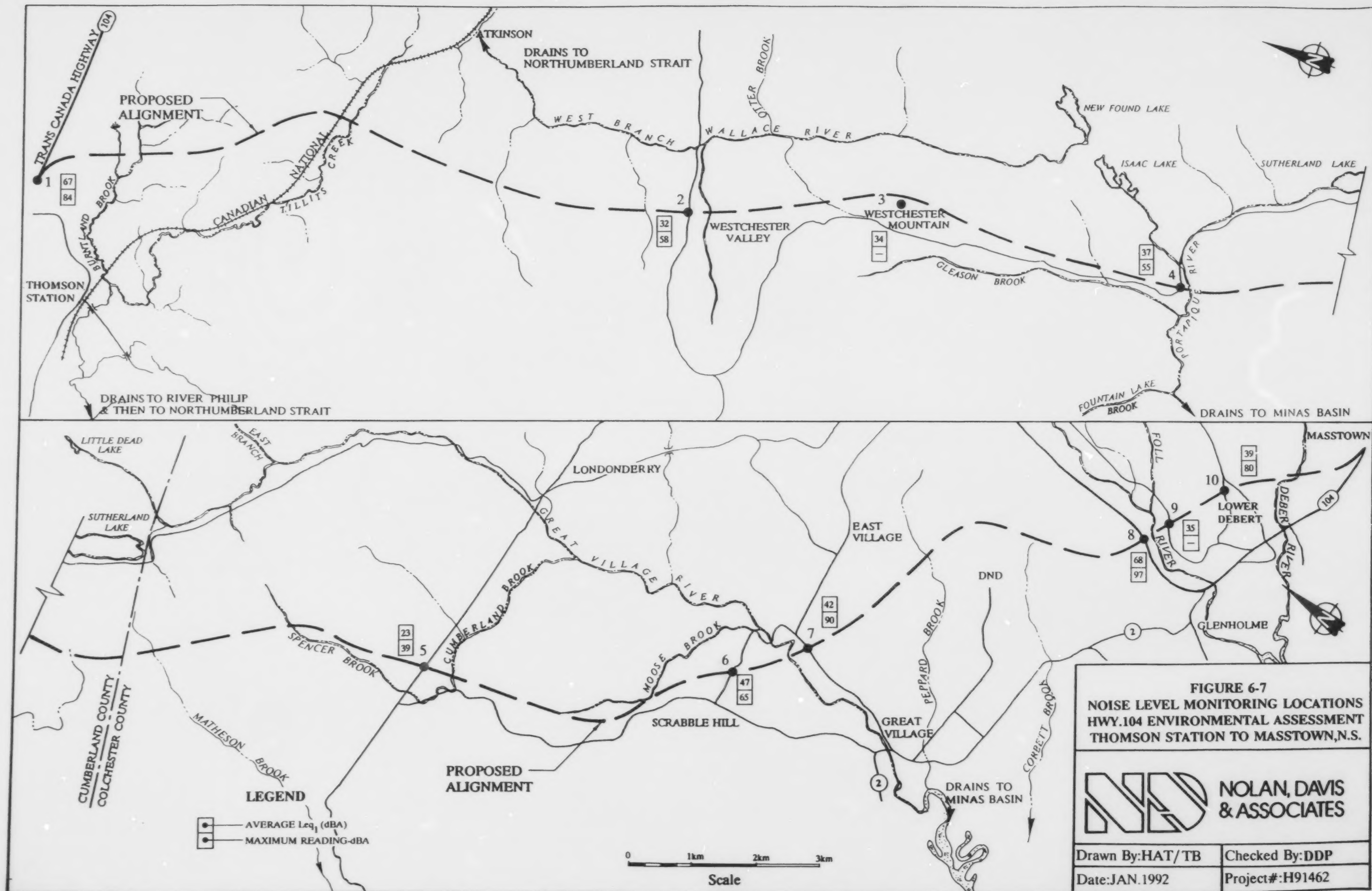


FIGURE 6-7
NOISE LEVEL MONITORING LOCATIONS
HWY.104 ENVIRONMENTAL ASSESSMENT
THOMSON STATION TO MASSTOWN, N.S.

NOLAN, DAVIS & ASSOCIATES

Drawn By: HAT/ TB

Checked By: DDP

Date: JAN. 1992

Project #: H91462



L_{eq} readings varied from 23 to 47 dBA at the rural, off-highway locations with an average of 36 dBA. Sound levels are normally elevated only by passing small vehicle traffic and the use of portable wood harvesting equipment or power tools. Some construction was taking place on adjacent properties and at one location (number 2), on the roadway nearby.

The existing sound environment can be characterized as relatively quiet (up to 40 dBA) at all of the rural locations, with the exception of intermittent disturbances. Locations adjacent to the existing Highway 104 have noise environments which have more elevated noise levels depending on the distance of the receptor from the roadway.

6.4 Aquatic Environment

6.4.1 Surface Water

The proposed corridor crosses a primary watershed on the Cobequid Highlands. Watercourses north of this divide flow into the Northumberland Strait and include the Wallace and Pugwash rivers and River Philip. Rivers which flow south off the Cobequid Mountains empty into the Minas Basin via Cobequid Bay and include the Portapique, Great Village, Folly and Debert Rivers.

The Cobequid Mountains portion of the study area is drained by nine river systems which follow a typical dendritic drainage pattern, that is, the rivers are characterized by an irregular "tree-like" branching of tributary streams. This type of dendritic pattern is primarily determined by the sloping, erosion resistant, granitic bedrock in the Cobequid Mountains.

TABLE 6-5
Sound Level Test Results
Highway 104 Alignment E.A.R.

Location Number	Location Description	L _{eq} dBA	Maximum Level dBA	Sound Sources
1	TCH 104 & new Alignment	67	84	Motor carriers, motor bike, recreation vehicle, school bus, pick-ups, cars. No residences. Right-of-way cleared, adjacent wooded.
2	Westchester-Collingwood Road & Alignment	32	58	0.15 km from shoulder repair operation on roadway produced maximum level, L _{eq} taken at 0.3 km from construction site. Residence near-by. Right-of-way mostly clear, adjacent wooded.
3	Westchester Mountain on Westchester Rd.	34	--	Wood cutting in distance, stream noise, no vehicle pass-bys. No residences. Gravel road. Berry field.
4	Westchester Road & alignment intersection	37	55	Mill noise, vehicle pass-bys, distance traffic, train and cutting noise. Gravel road. No residences. Cleared, gravel mining site, hill adjacent.
5	Mines-Bass River Road & alignment	23	39	Pounding (stapling) at adjacent property, birds, distant traffic. Gravel road. Residences nearby. Mostly clear, some brush.
6	Spencer Cross Road & alignment	47	65	Clear to north, wooded to south. Dominated by fire wood cutting operation. No residences. Gravel road.
7	Station Road & alignment	42	90	Vehicle passages, distant pounding, birds, maximum was close vehicle pass-by. Paved road. Open field. Residences adjacent.
8	Highway 104 N. of Glenholme & intersection with alignment	68	97	Motor carriers, various heavy and light duty traffic. Birds. Paved road. Wooded, open areas adjacent. Residences adjacent.
9	Gray Road & alignment	35	--	No traffic. Rte. 104 over crest of hill and downslope 1 km away. Gravel road. Open site with some trees. Residences in area.
10	Middle Road & alignment	39	80	Light vehicle passages, distant hammering, birds, aircraft, dominant noise is distant wheel hum from 104. Wooded, residences at distance.

Vaughan and Somers (1980), examined stream flow hydrographs from several stations in Cumberland County including the River Philip and Wallace River which have tributaries which cross the proposed alignment. This analysis resulted in the differentiation of runoff characteristics between upland, transitional, and lowland drainage basins. The upland watershed areas of the Cobequid Mountains produce hydrographs having sharp peaks, short times of concentration and high stream flow velocities. The upland drainage basins were found to have higher summer unit low flows than either the transitional or lowland drainage basins. The magnitude of runoff values for the transitional watersheds depended in part upon the relative proportions of upland versus lowland areas drained at any particular metering site.

Vaughan and Somers (1980), reported that regional runoff patterns in the area tend to vary in a north-south direction. Runoff was generally higher (900 mm - 1978 data) along the northern flank of the Cobequid Mountains, and decreasing (to 700 mm) towards the shores of the Bay of Fundy and the Northumberland Strait. Although long term stream flow records were not available for the Cobequid region, it was concluded that the highest annual and summer runoffs are likely in this region.

The differences in runoff characteristics over the region were attributed to a number of related factors (Vaughan and Somers, 1980). Regional runoff trends correlated closely with regional precipitation patterns. Of equal importance were the differences in the physical characteristics (i.e. slope, drainage density) of the drainage basins.

Vaughan and Somers (1980), concluded that significant sustained low flows are generally limited to Upland, and to a lesser extent, transitional watershed lands. Therefore, in terms of surface water supply potential, these mountain areas are of greatest importance to the region.

6.4.1.1 Surface Water Quality

Thirteen locations of streams on the proposed alignment were sampled on October 9 to 11, 1991. Sampling locations are shown in Figure 6-8.

Samples were obtained at mid-stream and mid-depth during non-rainfall conditions. The most recent precipitation event occurred on October 7, 1991 when less than 15 millimetres of rain was recorded. Table 6-6 presents the results obtained.

Two water samples were submitted for a scan chemical analysis to determine their major ion chemistry. One sample was obtained from the West Branch of the Wallace River (designated as location B on Figure 6-8); the other sample was obtained from the Great Village River (designated as location A on Figure 6-8). Results of the chemical analysis are given in Table 6-7.

The water quality data for both surface water samples are very similar and may be characterized as fresh (ion sum 23-28 mg/l), very soft, of low colour, non-turbid, calcium bicarbonate type waters (Figure 6-9). The analytical results indicate that the samples are only slightly acidic (pH 6.8) and of low alkalinity. Organic chemistry is characterized by low Total Organic Carbon values. Of the four metals monitored only iron was above detection limits but had relatively low concentrations. In terms of quality, and based on the parameters analyzed, this water is considered potable.

The average pH of rivers, streams and lakes within the study area is 6.5 to 7.0, indicative of a naturally high buffering capacity, even though the granite bedrock which underlies much of the Cobequid Mountains does not contribute significant acid buffering capacity to streams. Rivers and streams with a high buffering capacity are largely resistant to the effects of acidic precipitation.



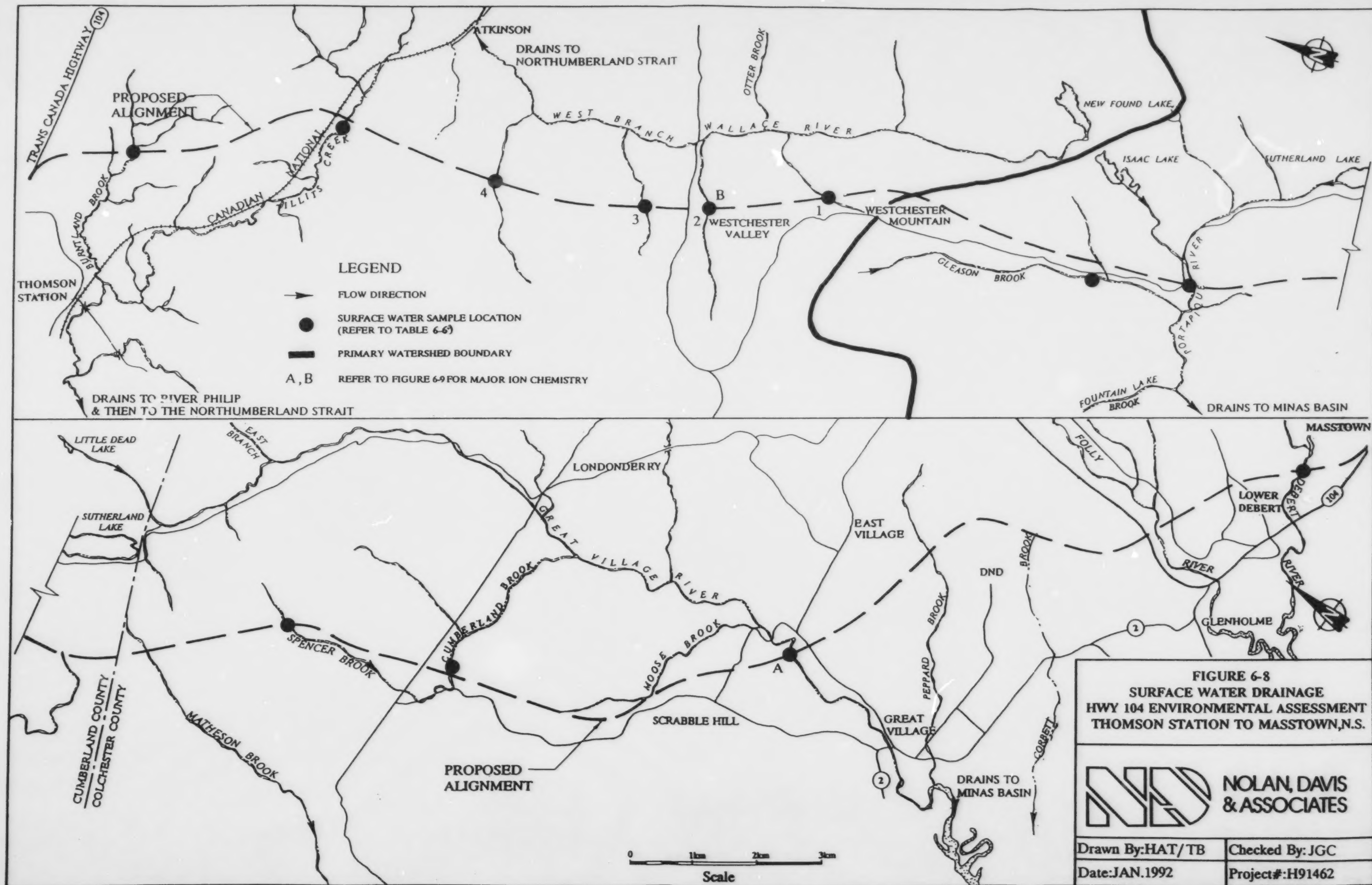


FIGURE 6-8
SURFACE WATER DRAINAGE
HWY 104 ENVIRONMENTAL ASSESSMENT
THOMSON STATION TO MASSTOWN, N.S.

NOLAN, DAVIS & ASSOCIATES

Drawn By: HAT/TB	Checked By: JGC
Date: JAN. 1992	Project#: H91462

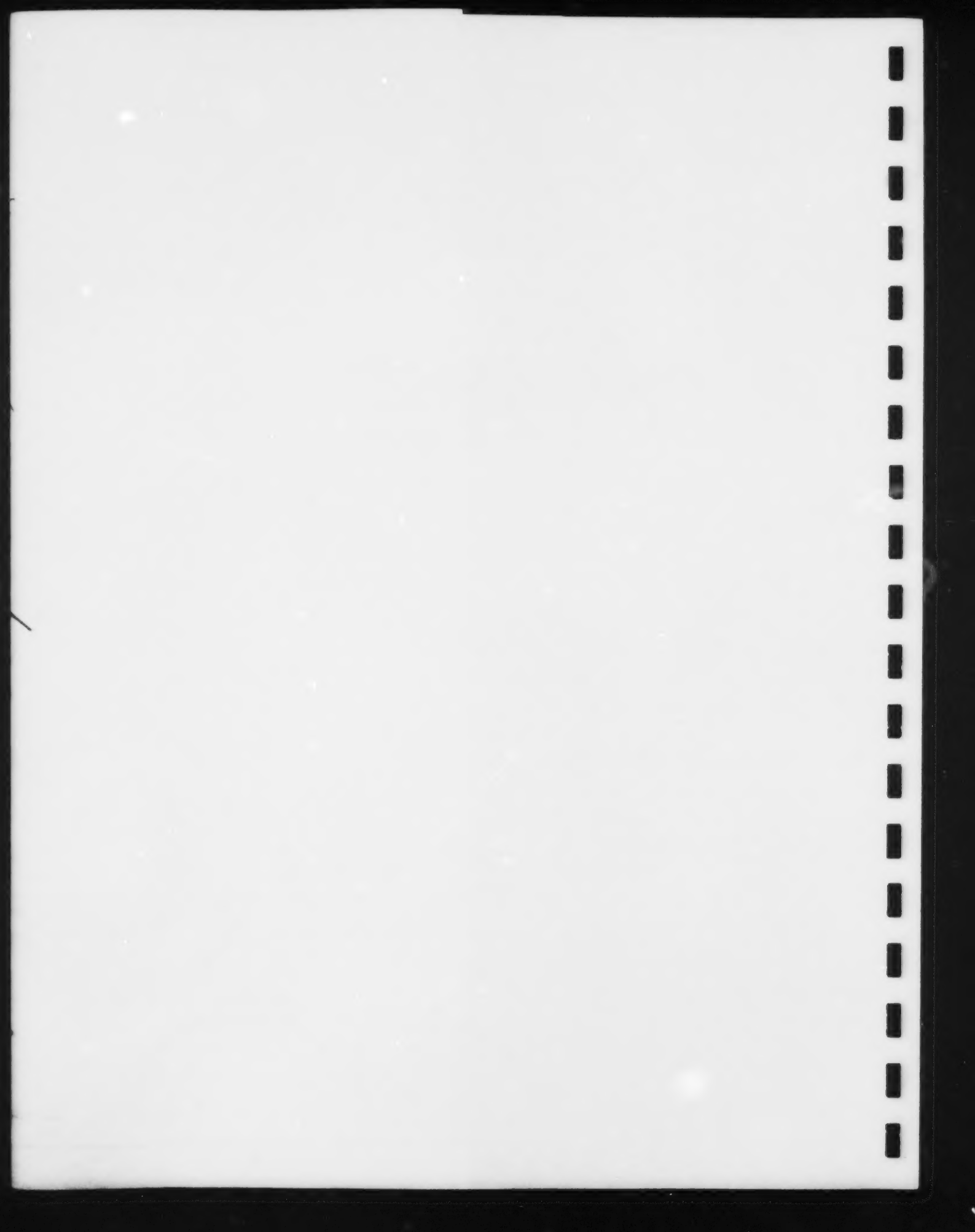


TABLE 6-6
Surface Water Quality Sampling Data
October 9-11, 1991

WATER COURSE	TEMP. C.	pH	SC umhos/cm	COLOUR TCU	TURBIDITY NTU	TSS mg/L	HUMIC ACIDS mg/L
Great Village River	N/A	6.8	35.0	17	0.51	1.3	5.9
West Branch Wallace River #1	9.4	5.9	26.0	43	0.93	N/A	N/A
West Branch Wallace River #2	10.6	6.8	40.0	17	0.86	2.0	5.7
West Branch Wallace River #3	9.4	5.8	31.0	45	0.49	N/A	N/A
West Branch Wallace River #4	10.6	6.4	33.0	13	0.38	N/A	N/A
Burntland Brook	8.9	6.6	63.0	51	1.11	N/A	17.8
Tillits Creek	N/A	6.2	33.0	130	1.13	N/A	27.4
Matheson Brook	9.4	6.7	68.0	10	0.29	N/A	N/A
Spencer Brook	10.6	6.2	28.0	3	0.27	N/A	N/A
Gleason Brook	8.3	6.3	43.0	5	0.31	N/A	N/A
Cumberland Brook	N/A	6.6	47.0	8	0.40	N/A	N/A
Debert River	N/A	6.4	42.0	45	0.58	N/A	N/A
Portapique River	10.6	6.4	44.0	15	0.39	N/A	N/A

Note: samples collected October 1991

TEMP: Temperature Degrees Celsius
SC: Specific Conductance
TSS: Total Suspended Solids

TCU: True Colour Units
NTU: Nephelometric Turbidity Units
N/A: Not Available

- see Table 6-7 for detailed chemistry of Great Village River & West Branch Wallace River

TABLE 6-7

Surface Water Quality Data

Parametre	Unit	Location A GVR	Location B WBWR	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life
Sodium	mg/L	2.1	2.7		
Potassium	mg/L	0.3	0.4		
Calcium	mg/L	2.90	3.20		
Magnesium	mg/L	0.7	0.9		
Hardness	mg/L	10.1	11.7		
Alkalinity (CaCO ₃)	mg/L	9.	10.		
Carbonate (CaCO ₃)	mg/L	0.01	0.01		
Bicarbonate (CaCO ₃)	mg/L	8.99	9.99		
Sulfate	mg/L	4.	4.		
Chloride	mg/L	2.7	3.9		
Silica	mg/L	5.1	6.7		
Ortho Phosphorus (P)	mg/L	<0.01	<0.01		
Nirate + Nitrite (N)	mg/L	<0.05	0.15		
Ammonia (N)	mg/L	<0.05	<0.05		~2
Iron	mg/L	0.03	0.06		0.3
Manganese	mg/L	<0.01	<0.01		
Copper	mg/L	<0.01	<0.01		0.002
Zinc	mg/L	<0.01	<0.01		0.03
Color	TCU	17.	17.	100	
Turbidity	NTU	0.51	0.86	+5 ¹	
Conductivity	umho/cm	35.	42.		
pH	units	6.8	6.8	5 to 9	6.5 to 9
Total Organic Carbon	mg/L	2.2	2.4		
Ion Sum	mg/L	23.	28.		

NOTE:

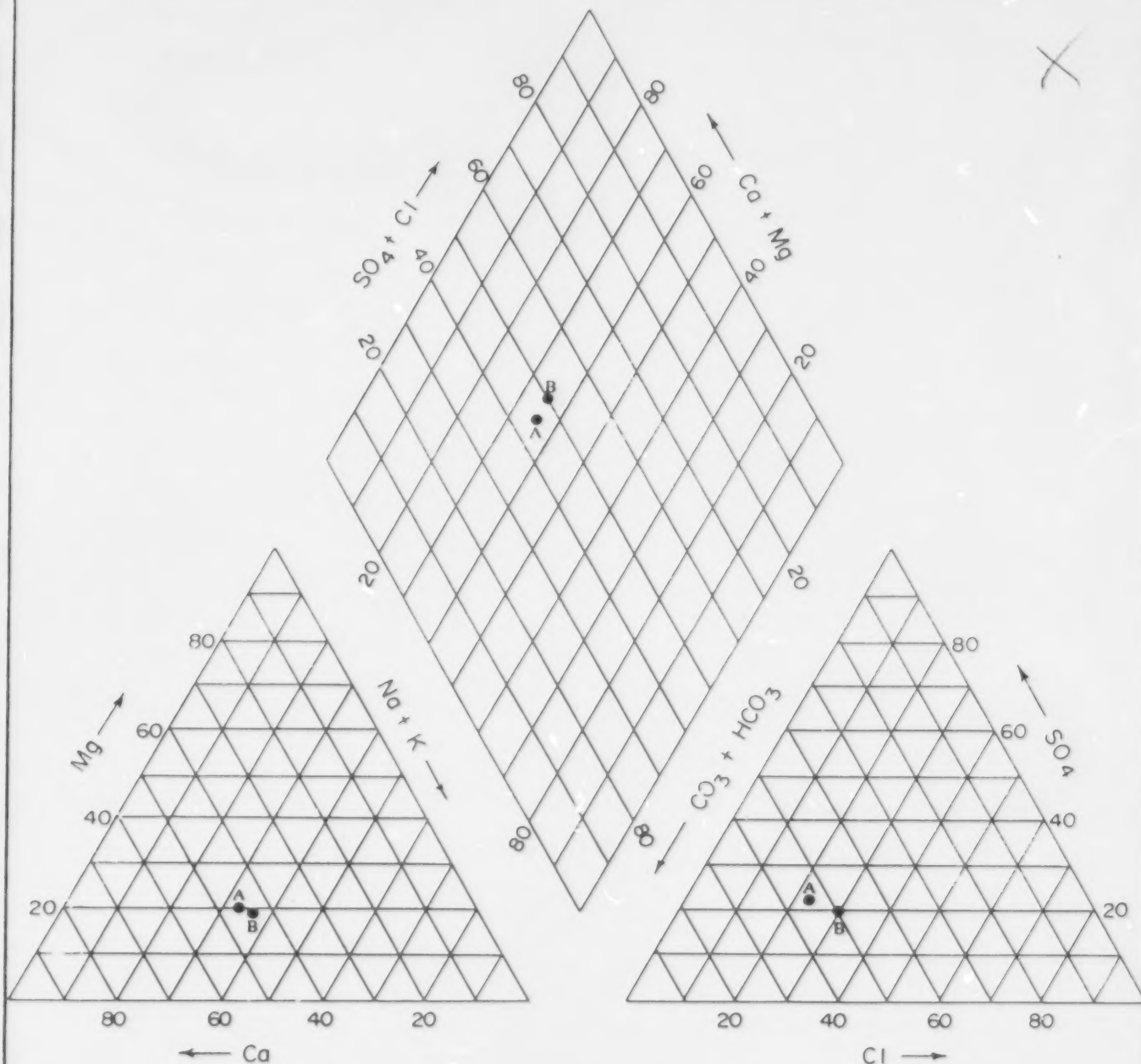
GVR - Great Village River - location A, Figure 6-8

WBWR - West Branch Wallace River - location B, Figure 6-8

TCU - True Colour Units

NTU - Nephelometric Turbidity Units

mg/L - milligrams per litre (equivalent to ppm)



PER CENT OF TOTAL EQUIVALENTS PER MILLION

LEGEND

- A SURFACE WATER
GREAT VILLAGE RIVER (DRAINS TO MINAS BASIN)
- B WEST BRANCH WALLACE RIVER #2 (DRAINS TO NORTHUMBERLAND STRAIT)



**NOLAN, DAVIS
& ASSOCIATES**

FIGURE 6-9
MAJOR ION CHEMISTRY
HIGHWAY 104 ENVIRONMENTAL ASSESSMENT
WESTERN ALIGNMENT
TRURO TO THOMSON STATION

6.4.1.2 Surface Water Use

There are no permits issued for the withdrawal of potable water from lakes or watercourses in the study area. All water withdrawal permits on record are for agricultural, industrial or recreational usage. However, it is reasonable to assume that there is unrecorded domestic use of the surface water resources by local residents.

The Cobequid Mountain Region has the potential for the development of surface water supplies. There are no known plans along the proposed alignment for the development of surface water watersheds for water supply purposes. The proposed alignment crosses the headwater reaches of Burntland Brook and Tillits Creek, tributaries of the River Philip. Given that Oxford Frozen Foods is using water from the River Philip, this river system may be developed at some time in the future as a supplementary water supply for the Town of Oxford.

6.4.2 Hydrogeology

An understanding of the geologic and hydrogeologic aspects along the proposed alignment is necessary to determine the potential environmental impacts to groundwater in the study area. Information on the characteristics (type, thickness, location, etc.) of the surficial and bedrock materials are necessary to understand the existing groundwater regimes which may be encountered during construction of the alignment.

Field reconnaissance groundwater well quantity and quality surveys for this proposed alignment will be implemented prior to any blasting operations along the corridor or at associated quarries. The proposed groundwater monitoring program is described in Section 10.3 of the report.

Vaughan and Somers (1980), have broadly identified five distinct hydrostratigraphic units in the study area; namely,

- 1) Igneous and metamorphic rocks of the Cobequid Mountains; and massive conglomerates of the lower Cumberland and Riversdale Groups;
- 2) Sedimentary sequences of Pictou, Cumberland and Riverside Groups within the Cumberland sedimentary basin;
- 3) Triassic sandstones of the Fundy Group
- 4) Pleistocene and Recent stratified deposits, and;
- 5) Till sheets

Within these broadly defined groups there are likely many distinct hydrostratigraphic units. A hydrostratigraphic unit is defined as geologic material(s) which has similar properties with regard to water storage and transmission capacity. Although in general, distinct water quality characteristics (i.e. hardness, colour, taste, etc.) can be attributed to various geologic materials, groundwater yields (quantity) are primarily governed by the geologic material's primary (pore spaces) and secondary (jointing/fracturing) permeability. The surface topography, geologic boundaries and other physical subsurface geologic conditions may also influence the yield from a hydrostratigraphic unit.

The igneous and metamorphic rocks of the Cobequid Highland Massif and conglomerates of the northern slope are characterized by narrow, steep-sided, hill and valley topography. Overburden cover is typically thin and stream networks expose the highly fractured crystalline and conglomeratic bedrock (Vaughan and Somers, 1980). The ability of these rock types to store and transmit groundwater is dependent mainly on the secondary permeability within the rock.

The groundwater derived from drilled wells tapping the bedrock of the CHM is generally of excellent quality; low in total dissolved solids and hardness, slightly acidic, and low in iron and manganese (Vaughan and Somers, 1980). However, the well yields are relatively low [0.11 L/sec to 0.3 L/sec (2 to 4 igpm)] compared to the lowland area wells. These yields are generally only sufficient for domestic consumption.

The low population base along the alignment dictates that the number of wells which tap groundwater supplies would also be minimal. NSDOE water well records indicate that drilled wells which tap bedrock aquifers are more prevalent in the Northumberland Coastal Lowland and Minas Lowland areas than on the CHM. Information obtained from NSDOE Water Well Records (1968-1990) on wells situated in the study corridor is presented in Table 6-8 and their locations shown in Figure 6-10.

Because the specific alignment within the corridor is presently not defined it is impossible to definitively describe which of these sources will be directly impacted by the project. However, as previously stated all wells in the vicinity of the finalized right of way will be surveyed before construction (see Section 10.3) and appropriate compensation negotiated for any sources adversely impacted by the project, including the provision of alternate supplies where necessary.

The permeable sandstones of the Pictou, Cumberland and Riversdale Groups situated in the Northumberland Coastal Lowlands represent important hydrostratigraphic units in the study area (Vaughan and Somers, 1980). These rock units are characterized by both primary permeability associated with interstitial flow and secondary permeability within fracture zones and bedding planes (ibid.).

The permeable sandstones of the Fundy Group also represent an important hydrostratigraphic unit within the study area (Hennigar, 1972). These rocks, which are located in the Minas Lowland area, are generally characterized by both primary and secondary permeability as noted in the sedimentary rocks of the Northumberland Coastal Lowlands.

The groundwater quality of the drilled wells located in the sedimentary bedrock sequences of the two lowland areas is considered to be generally good and characterized by calcium, magnesium carbonate and bicarbonate alkalinities (Vaughan and Somers, 1980). The groundwater is generally low in hardness and total dissolved solids, high



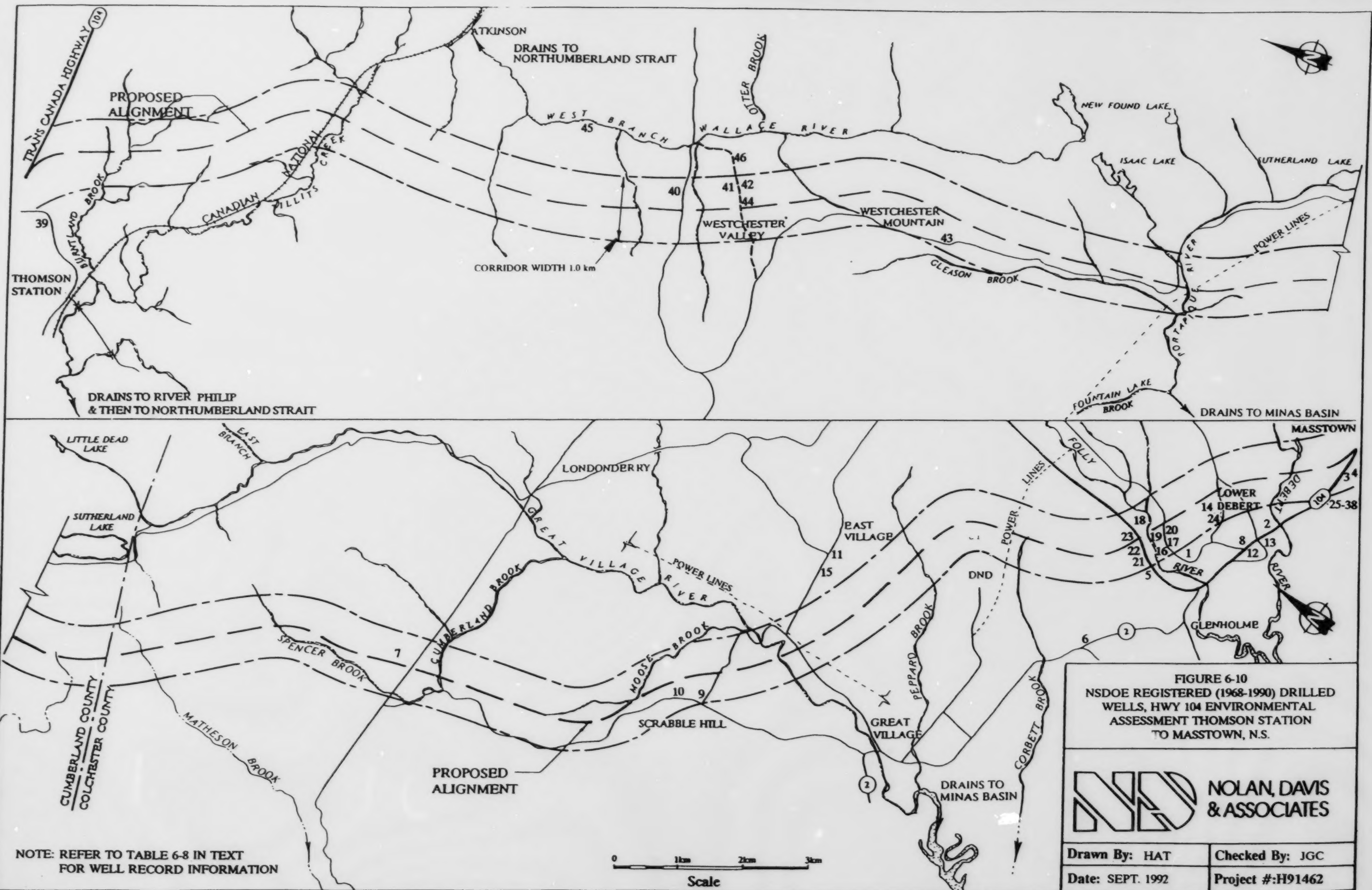




TABLE 6-8
NSDOE WATER WELL RECORDS
for Proposed Alignment Corridor

Location on
Figure 6-10

	Owner	Address	Well Depth (m)	Well Yield (l/gpm/ps)	Aquifer	Year Drilled
1	J. Rafuse	Col. Co.	26.8	10/0.76	Sandstone	1968
2	H. Andrews	Col. Co.	53.3	5/0.38	Sandstone	1972
3	Mantown Motel	Col. Co.	61.6	10/0.76	Shale	1972
4	Mantown Motel	Col. Co.	46.0	25/1.89	Sandstone	1972
5	Art McElhinney	Col. Co.	30.5	N/A	Sandstone	1973
6	Art McElhinney	Col. Co.	22.9	6/0.45	Sandstone	1973
7	Wayne Rushton	Col. Co.	20.1	N/A	Shale/Sandstone	1973
8	E. Jennings	Col. Co.	36.6	2/0.15	Shale	1974
9	D. Thompson	Col. Co.	28.7	12/0.91	Sandstone	1974
10	D. Adams	Col. Co.	25.6	3/0.23	Sandstone	1974
11	Melvin Corbett	Col. Co.	19.8	20/1.52	Gravel	1976
12	Royden Yorke	Col. Co.	49.4	4/0.30	Sandstone	1977
13	Mike Long	Col. Co.	42.7	10/0.76	Sandstone/Conglomerate	1977
14	John Phillips	Col. Co.	42.7	6/0.45	Shale	1977
15	Mr. Adams	Col. Co.	30.5	8/0.61	Sandstone	1977
16	Arnold Spencer	Glenholme	37.8	5/0.38	Sandstone	1981
17	Robert Dennis	Lwr. Debert	24.4	6/0.45	Sandstone	1982
18	Paul Suttle	Glenholme	33.2	6/0.45	N/A	1982
19	Joe Rafuse	Glenholme	31.7	12/0.91	Conglomerate	1983
20	Chas. Harrington	Glenholme	31.7	10/0.76	Conglomerate	1983
21	Michael Jennings	Glenholme, TCH	25.3	0/0	Conglomerate	1984
22	John Harrington	RR#1 Brookfield	36.6	20/1.52	Sandstone	1985
23	Howard Burton	RR#1 Debert	36.6	6/0.45	Sandstone/Shale	1988
24	Ray Rushton	RR#1 Debert	30.5	12/0.91	Sandstone/Shale	1986
25	Weir & Toole, Brookside	Mantown	18.3	5/0.37	Sandstone	1968
26	Weir & Toole, Brookside	Mantown	24.7	8/0.61	Sandstone	1969
27	Weir & Toole, Brookside	Mantown	26.5	8/0.61	Sandstone	1969
28	G. Denmore	Mantown	25.9	8/0.61	Sandstone	1972
29	J. Halliday	Mantown	24.7	10/0.76	Sandstone	1972
30	H. Gerrior	Mantown	16.2	10/0.71	Sandstone	1974
31	J. Gray	Mantown	22.9	15/1.14	Sandstone	1974
32	Hank Faber	Mantown	27.4	8/0.61	Sandstone	1974
33	Hank Faber	Mantown	31.7	20/1.52	Sandstone	1975
34	Wilfred Allen	Mantown	18.3	10/0.76	Sandstone	1982
35	Fred Robinson	Mantown	15.2	10/0.76	Shale	1981
36	J & A Contractors	Mantown	31.1	8/0.61	Sandstone	1986
37	Eldred Olmstead	PMQ 384 Camp Debert	24.4	12/0.91	Sandstone	1986
38	Hendrick Admiral	Vance Dr., Mantown	31.7	8/0.61	Sandstone	1987
39	Alan Swan	Thompson Station	20.1	4/0.30	Shale	1973
40	M.A. Ummiani	Westchester Valley	46.9	4/0.30	Sandstone/Shale	1974
41	Don Reid	Westchester Valley	29.0	5/0.38	Shale	1975
42	Joseph DeYoung	Westchester Valley	54.9	2.5/0.19	Shale	1975
43	Carson Staples	Westchester Valley	61.0	1/0.08	Gravel?	1977
44	David Adams	Westchester Valley	12.5	3.5/0.27	Sandstone	1982
45	David Moore	Westchester Valley	13.7	2/0.15	Gravel?	1983
46	Douglas Dobson	Westchester Valley	13.7	12/0.91	Gravel?	1984

in pH, and may occasionally exhibit elevated iron and manganese concentrations. Yields ranging from 0.3 L/ (4 igpm) to 45.6 L/s (600 igpm) have been documented for water wells drilled in these bedrock formations on a regional scale.

The stratified sand and gravel glaciofluvial deposits are generally found associated with ancient bedrock valleys (Vaughan and Somers, 1980). These deposits, where present, may have significant groundwater resource potential, if properly developed and protected from contamination.

The groundwater produced by these surficial aquifers is also of good quality - low in total dissolved solids, hardness, iron and manganese (Vaughan and Somers, 1980).

Glacial till sheets mantle much of the lowland areas and parts of the Cobequids. Generally, only small quantities of groundwater can be obtained from these deposits, sufficient only for individual domestic purposes. Water discharging from springs is utilized by some residences situated at or near the northern and southern flanks of the CHM. Public meetings with regard to the proposed construction of the corridor indicated that residents were concerned about the potential impacts that highway construction might have on these springs. Potential impacts are identified and discussed in Section 7.2.

6.4.3 Fish

Existing data on fish distributions along with electrofishing and other project specific field surveys were used to describe the aquatic biology resources along the proposed alignment. Information from Fisheries & Oceans Canada, Nova Scotia Department of Fisheries, and the Nova Scotia Museum, along with sport fishing catch statistics, was used to help rank the relative sensitivity of water crossings within the various river systems. Results of electrofishing surveys along the proposed alignment are provided in Table 6-9, with sampling locations shown on Figure 6-11.



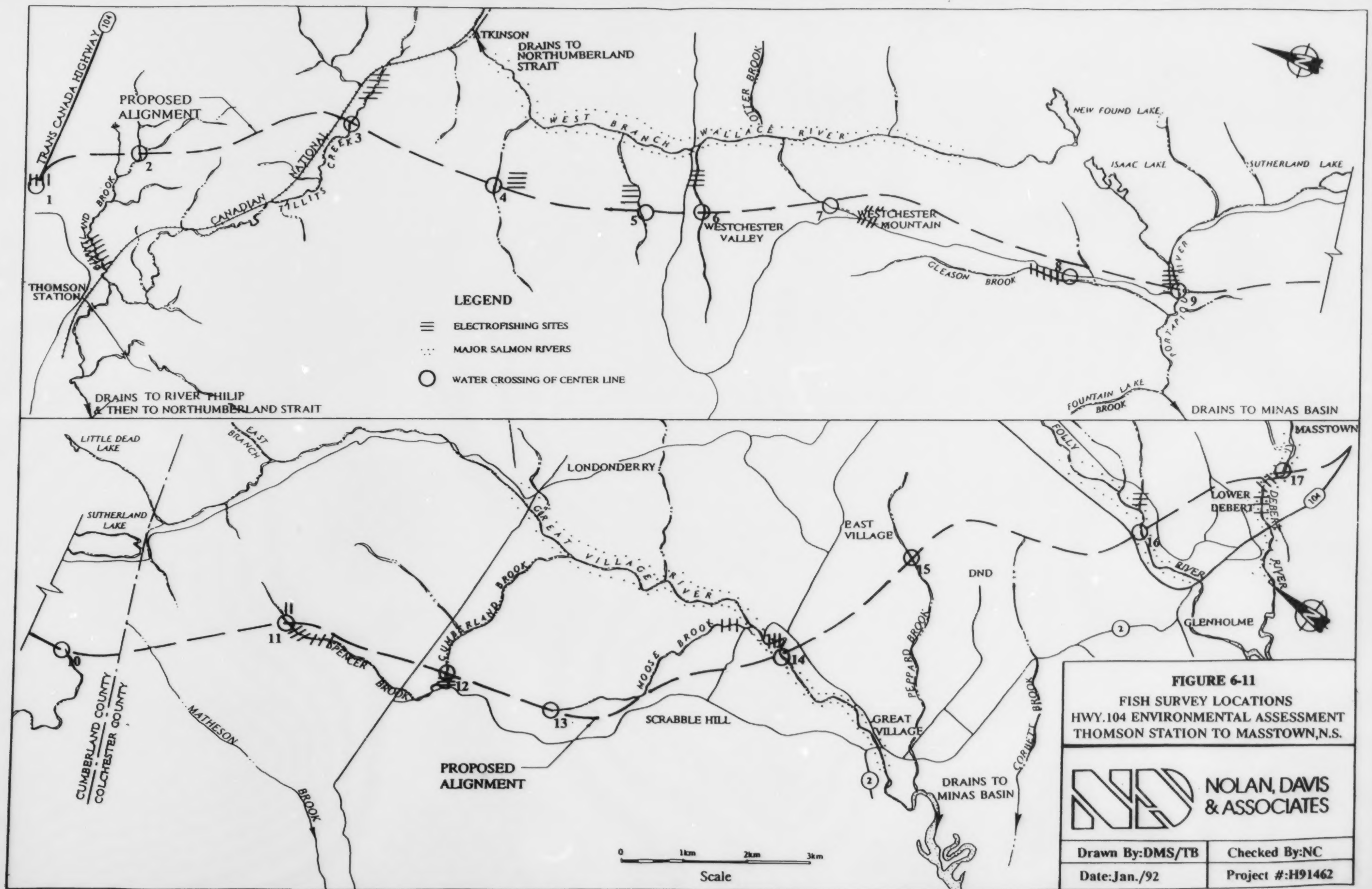




TABLE 6-9

Electrofishing Survey Results October 8, to October 11, 1991

Watershed	River	Number	Location	Species	Nos.	Length (cm)	Stage
Pugwash River	unnamed tributary	1	Northern edge of corridor to C/L	Threespine stickleback (<i>Gasterosteus aculeatus</i>)	3	2.0 - 2.5	
				Blacknose shiner (<i>Notropis heterolepis</i>)	1	3.00	
River Philip	Burntland Brook	2	2.0 km southeast along Thomson St. Cemetery Road	Atlantic salmon (<i>Salmo salar</i>)	4	9.0 - 12.5	parr
				Atlantic salmon (<i>Salmo salar</i>)	14	4.0 - 8.0	fry
				Brook trout (<i>Salvelinus fontinalis</i>)	15	8.5 - 15.5	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	12	4.0 - 7.5	fry
				Threespine stickleback (<i>Gasterosteus aculeatus</i>)	9	2.0 - 2.5	
River Philip	Tillitis Brook		1.25 km northwest of Atkinson	Blacknose dace (<i>Rhinichthys atratulus</i>)	7	4.0 - 5.0	
		3		White sucker (<i>Catostomus commersoni</i>)	32	5.5 - 9.0	
				Threespine stickleback (<i>Gasterosteus aculeatus</i>)	5	2.0 - 2.25	
				Blacknose dace (<i>Rhinichthys atratulus</i>)	8	4.0 - 5.0	
				Atlantic salmon (<i>Salmo salar</i>)	4	4.0 - 6.5	fry
West Branch Wallace	unnamed tributary	4	1.75 km south of Atkinson	Brook trout (<i>Salvelinus fontinalis</i>)	19	10.0 - 19.5	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	3	3.0 - 5.0	fry
				Threespine stickleback (<i>Gasterosteus aculeatus</i>)	3	2.0 - 2.25	
				Atlantic salmon (<i>Salmo salar</i>)	8	4.5 - 6.0	fry
West Branch Wallace	unnamed tributary	5	3.25 km south of Atkinson	Brook trout (<i>Salvelinus fontinalis</i>)	7	8.5 - 18.5	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	21	3.5 - 8.0	fry
				Atlantic salmon (<i>Salmo salar</i>)	18	9.5 - 16.0	parr
West Branch Wallace	unnamed tributary	6	50 m south of road to Westchester	Atlantic salmon (<i>Salmo salar</i>)	17	3.0 - 5.0	fry
		7		Brook trout (<i>Salvelinus fontinalis</i>)	1	7.5	fingerling
Portapique River	unnamed tributary to Gleason Brook		3.5 km south on West- chester Valley Road	Brook trout (<i>Salvelinus fontinalis</i>)	3	3.0 - 5.0	fry
		8		Atlantic salmon (<i>Salmo salar</i>)	9	10.0 - 11.0	parr
				Atlantic salmon (<i>Salmo salar</i>)	16	4.0 - 6.5	fry
				Brook trout (<i>Salvelinus fontinalis</i>)	2	10.0 - 12.5	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	3	3.0 - 5.5	fry
				Blacknose dace (<i>Rhinichthys atratulus</i>)	2	4.0	

Continued

TABLE 6-9 (Cont')

Electrofishing Survey Results October 8, to October 11, 1991

Watershed	River	Number	Location	Species	Nos.	Length (cm)	Stage
Portapique River	main channel	9	100 m south of aggregate quarry north of Sutherland Lake	Brook trout (<i>Salvelinus fontinalis</i>)	12	18.0 - 21.5	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	29	13.0 - 18.0	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	19	5.0 - 8.0	fry
Portapique River	Matheson Brook	10	7.8 km d/s of corridor at Lornevale	Atlantic salmon (<i>Salmo salar</i>)	7	8.5 - 11.0	parr
				Atlantic salmon (<i>Salmo salar</i>)	14	6.0 - 8.5	fry
				Brook trout (<i>Salvelinus fontinalis</i>)	3	8.0 - 12.5	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	5	3.0 - 7.5	fry
Great Village River	Spencer Brook	11	3.0 km along logging road south of Sutherland Lake	Brook trout (<i>Salvelinus fontinalis</i>)	42	10.0 - 16.5	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	17	3.5 - 5.5	fry
				Blacknose Dace (<i>Rhinichthys atratulus</i>)	3	4.5 - 6.0	
Great Village River	Cumberland Brook	12	1.0 km south of corner of Londonderry Rd. and Scrabble Hill Rd.	Atlantic salmon (<i>Salmo salar</i>)	27	6.0 - 8.5	fry
				Brook trout (<i>Salvelinus fontinalis</i>)	23	8.0 - 10.5	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	5	3.0 - 8.0	fry
				Common shiner (<i>Notropis cornutus</i>)	1	4.0	
Great Village River	Moose Brook	13	6.7 km d/s of C/L north of Scrabble Hill	Atlantic salmon (<i>Salmo salar</i>)	7	4.0 - 6.5	fry
				Brook trout (<i>Salvelinus fontinalis</i>)	21	9.0 - 19.0	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	7	3.0 - 6.0	fry
				Blacknose shiner (<i>Notropis heterolepis</i>)	2	2.0 - 3.0	
Great Village River	main channel	14	50 m d/s of bridge north of Great Village	Brook trout (<i>Salvelinus fontinalis</i>)	32	12.0 - 23.0	yearling
				Brook trout (<i>Salvelinus fontinalis</i>)	17	3.0 - 8.0	fry
				American eel (<i>Anguilla rostrata</i>)	9	6.0 - 10.0	
				Blacknose Dace (<i>Rhinichthys atratulus</i>)	4	4.0 - 5.0	
				Threespine stickleback (<i>Gasterosteus aculeatus</i>)	5	1.5 - 2.5	

Continued

TABLE 6-9 (Cont')

Electrofishing Survey Results October 8, to October 11, 1991

Watershed	River	Number	Location	Species	Nov.	Length (cm)	Stage
Great Village River	Peppard Brook	15		NA			
Folly River	unnamed tributary	16	1.25 km u/s of 104 bridge	Atlantic salmon (<i>Salmo salar</i>) Atlantic salmon (<i>Salmo salar</i>) Brook trout (<i>Salvelinus fontinalis</i>) Brook trout (<i>Salvelinus fontinalis</i>) Creek chub (<i>Semotilus atromaculatus</i>)	3 4 28 7 1	9.0 - 12.0 4.5 - 5.0 9.0 - 15.0 5.0 - 7.0 6.5	parr fry yearling fry 6.5
Debert River	main channel	17	250 m u/s of 104 bridge	Atlantic salmon (<i>Salmo salar</i>) Atlantic salmon (<i>Salmo salar</i>) Brook trout (<i>Salvelinus fontinalis</i>) Brook trout (<i>Salvelinus fontinalis</i>) American eel (<i>Anguilla rostrata</i>) Blacknose Dace (<i>Rhinichthys atratulus</i>)	4 5 19 7 3 4	8.0 - 11.5 4.5 - 8.0 7.0 - 12.0 3.0 - 6.0 5.0 - 9.0 4.0 - 5.0	parr fry yearling fry fry 4.0 - 5.0

Notes:

u/s - upstream
d/s - downstream

6.4.3.1 Recreational Fisheries

Recreational fishing is important on all rivers within the study area. Sport fishing statistics are available by county from provincial fishing license stub returns. In 1985, the total of resident and non-resident days fished for Cumberland and Colchester Counties was 117,519 days fished, approximately 9.7 percent of the total angling effort in Nova Scotia (Department of Fisheries and Oceans, 1988). This recreational activity was worth approximately \$2.3 million. Cumberland and Colchester County residents who fished spent between 69 and 78 percent of their fishing time within their home county. Residents of Colchester County are the most likely non-residents to fish in Cumberland County, and residents of Cumberland County are the most likely non-resident fishermen in Colchester County (Department of Fisheries and Oceans, 1988).

Brook trout, followed by Atlantic salmon, are by far the most popular fish angled in Colchester and Cumberland counties. In 1985 brook trout comprised between 80 to 88 percent of the total recreational catch in Colchester and Cumberland counties (Department of Fisheries and Oceans, 1988). Brook trout are probably found in all cool, well oxygenated streams and lakes in the study area. Even small (first order) streams that receive some groundwater flow likely provide important brook trout habitat. Brook trout spawn in the early autumn on gravel beds near the head-waters of streams or in areas with a similar gravel substrate and moderate upwelling flow.

A hatchery near Williamsdale on River Philip historically supplied the trout and salmon for restocking areas within Cumberland and Colchester Counties. Stocking of hatchery-raised brook trout has taken place on every major lake and river within the Cobequid area.

All of the river systems within the study area support a wild population of Atlantic salmon. The Atlantic salmon is an anadromous species, returning from the sea to spawn in freshwater rivers and streams in the autumn. Young salmon spend two to four years in freshwater before returning to the sea where they experience rapid growth.

The rivers of the inner Bay of Fundy and Northumberland Strait are late run rivers, that is, salmon return to spawn between October and November (Amiro, 1987; MacEachern, 1961). River Philip has the highest reported angling catches for rivers in the study area, however, only the eastern corner of the River Philip watershed is crossed by the Western Alignment. The Wallace River, has the second highest reported salmon catches for the study area. The alignment crosses several un-named tributaries of this system. Reported salmon catches from Folly and Debert Rivers are slightly lower than those from the Wallace River, while a few salmon are reported caught from the Great Village River.

Salmon have been stocked into the Folly and Debert Rivers, and extensively along River Philip. The Cumberland County River Enhancement Association has been active in mapping important fish habitat and assisting in enhancement activities in Cumberland County. The Association began surveys of the Wallace River this spring but has generally been most active east of the study area. A Colchester County river enhancement group has also been recently formed.

The recreational sports fishery in these counties also includes brown trout, rainbow trout, smallmouth bass, white perch, yellow perch, striped bass, and shad. There are no reports of rainbow trout being caught on any of the rivers crossed by the proposed alignment, and the Wallace River is the only river with a recorded brown trout catch. Other species of non-recreational fish which are also found in the study area are american eel, northern lake chub, three-spine stickleback, blacknose dace, white sucker, and lamprey eel.

6.4.3.2 Rare Species

Five rare or endangered aquatic or semi-aquatic species are found within the study area. These include the brook stickleback, blacknose dace, pearl mussel, small clam, and the wood turtle.

The brook stickleback (*Culaea inconstans*) and the blacknose dace (*Rhinichthys atratulus*) are the only rare or endangered species of fish found in the study area. The brook

stickleback is one of five stickleback species found in Nova Scotia. Strictly a freshwater species of stickleback, it inhabits cold, densely vegetated waters of small streams and brooks, and marshy wetland areas associated with small lakes and ponds. Like most sticklebacks, it is of no direct commercial importance, nor is it a significant species in salmonid diet. Although rare in this province, it is common throughout northern-central North America (Gilhen, 1974).

In Nova Scotia, brook stickleback populations are known to be present only within Cumberland County watersheds which empty into the Northumberland Strait. Several specimens were collected in the River Philip watershed, in the Oxford area near the present Highway 104 (Gilhen, 1985). However, no brook stickleback were caught during electrofishing in October, 1991, in Tillits and Burntland brooks, tributaries to the River Philip.

The blacknose dace is rare in Nova Scotia but common in New Brunswick and many others parts of northeastern North America. It has been reported to be in the River Philip, Sutherland Lake, Portapique and Wallace rivers, and Atkinson Brook (Isnor, 1981). Blacknose dace were caught in the main river or tributaries to the River Philip and Portapique, Great Village and Debert rivers during electrofishing in October, 1991.

The pearl mussel (*Margaritifera margaritifera*) and the small clam (*Sphaerium simile*) are both rare freshwater molluscs. The pearl mussel inhabits cold, clean gravel bottom rivers and streams associated with trout habitat. Globally, it is vulnerable to habitat destruction through siltation and commercial overfishing for its freshwater pearls. In Nova Scotia it is not commercially exploited, but it may provide food for raccoons and muskrats. The pearl mussel, although commonly found in Nova Scotia, is listed as a globally endangered species. The pearl mussel is found in the Chiganois River outside the study area and has not been reported from rivers crossed by the proposed corridor. The small clam may be found throughout the study area where muddy bottomed, flat, marshy brooks exist, but it would be expected to be relatively uncommon. Neither pearl mussels nor small clams

were observed during October field surveys but visibility was poor during the high fall flows.

The wood turtle (*Clemmys insculpta*) is endangered in Nova Scotia due to destruction of its nesting areas and collection as pets. Within the study area the wood turtle may be found in valley rivers and ponds inhabiting deep freshwater pools with muddy bottoms and sandy shores. Wood turtle habitat was not observed near any of the proposed crossings.

6.4.4 Water Crossings

A total of 17 water crossings were initially identified from 1:50,000 topographic mapping of the proposed alignment. Each of these crossings was numbered beginning in the northwest. Field surveys in October, 1991, indicated that an unnamed tributary of the Burntland Brook (Crossing 1), Moose Brook (Crossing 13), and Peppard Brook (Crossing 15) were poorly defined seasonal drainage channels that did not provide fish habitat. Tables 6-10 and 6-11 provide a description of the fish habitat at each of the crossings of the proposed alignment. The significant crossings are described in more detail within each major watershed crossed. Since Atlantic salmon and various species of trout are by far the most important recreational species, the description of each stream or river within the one kilometre wide corridor concentrates on the quality of salmonid habitat provided.

6.4.4.1 River Philip

Crossings 2 and 3 are located within the River Philip watershed. Crossing 2 is over Burntland Brook and its associated fen. This crossing is less than five metres wide at the approximate centerline of the proposed highway crossing. The substrate has a high percentage of sand and silt, eliminating the potential for use of the crossing area as spawning habitat by salmonids. The banks of the stream are approximately 0.5 metres high and easily erodible. The approaches to the river are shallow gentle slopes characteristic of a flood plain. While the stream does not provide salmonid spawning habitat, salmon and speckled trout fry and parr were caught during electrofishing.

TABLE 6-10

Characteristics of Water Crossings

Watershed	River	Number	at Centreline of Alignment			Stream Flow	Stream Gradient*
			Stream Velocity (m/s)	Stream Width (m)	Water Depth (m)		
River Philip	tributary to Burtland Bk.	1	intermittent drainage channel - no fish habitat				
River Philip	Burntland Brook	2	0.66	4.20	0.60	medium	0.9%
River Philip	Tillits Brook	3	0.23	3.90	0.72	medium	0.8%
West Branch Wallace	unnamed tributary	4	0.57	1.90	0.20	medium	2.5%
West Branch Wallace	unnamed tributary	5	0.40	2.00	0.30	medium	1.9%
West Branch Wallace	unnamed tributary	6	0.98	2.40	0.25	medium	1.7%
West Branch Wallace	unnamed tributary	7	0.53	1.75	0.13	medium	9.1%
Portapique River	Tributary to Gleason Bk.	8	intermittent drainage channel - no fish habitat				
Portapique River	Main Channel	9	0.70	5.60	0.40	high	1.3%
Portapique River	Matheson Brook	10	0.58	2.50	0.28	high	5.0%
Great Village River	Spencer Brook	11	0.37	1.80	0.15	medium	5.0%
Great Village River	Cumberland Brook	12	0.80	6.40	0.17	medium	2.0%
Great Village River	Moose Brook	13	intermittent drainage channel - no fish habitat				
Great Village River	Main Channel	14	0.74	24.70	0.47	high	0.1%
Great Village River	Peppard Brook	15	intermittent drainage channel - no fish habitat				
Folly River	Main Channel	16	survey not completed because of high water levels				
Debert River	Main Channel	17	1.43	33.50	0.53	high	0.1%

Note: *gradient at the actual crossing, based on contours on 1:10,000 orthophoto mapping.

Table 6-11
Habitat Survey of Water Crossings

Crossing Number	Distance u/s from Corridor (m)	% Bank Stability	Instream Cover	Percent Pool	Stream Substrate						Habitat Quality
					cl	si	sa	gr	co	bo	
2	0-225	0-50% unstable	70% undercut banks, 45% instream debris	60%	35	10	35	20	0	0	poor salmon spawning, good rearing
	225-450	0-50% unstable	80% undercut banks, 60% instream debris	60%	20	20	35	25	0	0	poor salmon spawning, good rearing
	450-650	0-50% unstable	60% undercut banks, 50% instream debris	60%	30	30	30	20	0	0	poor salmon spawning, good rearing
	650-1000	0-50% unstable	70% undercut banks, 80% instream debris	60%	35	25	25	15	0	0	poor salmon spawning, good rearing
3	0-325	0-50% unstable	70% undercut banks, 35% instream debris	80%	20	35	35	10	0	0	beaver habitat, poor fish passage
	325-550	0-50% unstable	90% undercut banks, 20% instream debris	80%	30	30	30	10	0	0	beaver habitat, poor fish passage
	550-950	0-50% unstable	60% undercut banks, 25% instream debris	70%	35	35	25	5	0	0	beaver habitat, poor fish passage
	950-1000	0-50% unstable	80% undercut banks, 35% instream debris	90%	30	35	30	5	0	0	beaver habitat, poor fish passage
4	0-300	50-75% moderate	30% undercut banks, 20% instream debris	40%	20	10	35	35	0	0	poor salmon spawning, good rearing
	300-620	50-75% moderate	60% undercut banks, 70% instream debris	60%	10	20	35	30	5	0	poor salmon spawning, good rearing
	620-840	50-75% moderate	40% undercut banks, 60% instream debris	30%	10	10	50	30	0	0	poor salmon spawning/rearing
	840-1000	50-75% moderate	60% undercut banks, 80% instream debris	40%	15	15	35	35	0	0	poor salmon spawning/rearing
5	0-250	50-75% moderate	40% undercut banks, 40% instream debris	60%	25	10	35	30	0	0	poor salmon spawning, good rearing
	250-450	50-75% moderate	40% undercut banks, 50% instream debris	70%	20	20	30	30	0	0	poor salmon spawning, good rearing
	450-525	50-75% moderate	30% undercut banks, 20% instream debris	40%	20	10	35	35	0	0	poor salmon spawning, good rearing
	525-625	50-75% moderate	50% undercut banks, 70% instream debris	60%	20	30	15	35	0	0	poor salmon spawning, good rearing
6	625-1000	50-75% moderate	50% undercut banks, 60% instream debris	50%	20	10	35	35	0	0	poor salmon spawning, good rearing
	0-125	50-75% moderate	35% undercut banks, 20% instream debris	60%	0	5	10	30	45	10	good salmon rearing, good spawning
	125-250	50-75% moderate	30% undercut banks, 25% instream debris	50%	0	10	10	10	50	20	good salmon rearing, good spawning
	250-750	50-75% moderate	20% undercut banks, 50% instream debris	30%	0	0	5	25	35	35	good salmon spawning/rearing
7	750-1000	0-50% unstable	30% undercut banks, 40% instream debris	50%	0	0	10	10	40	40	good salmon spawning/rearing
	0-300	50-75% moderate	5% undercut banks, 70% instream debris	10%	0	0	5	5	5	85	poor trout spawning, marginal rearing
	300-850	50-75% moderate	5% undercut banks, 70% instream debris	40%	0	0	10	10	10	70	poor trout spawning, marginal rearing
	850-1000	50-75% moderate	5% undercut banks, 70% instream debris	60%	0	0	10	10	10	70	poor trout spawning, marginal rearing
9	0-55	75-100% stable	30% undercut banks, 20% instream debris	80%	0	0	0	10	50	40	good salmon rearing, marginal spawning
	55-135	75-100% stable	30% undercut banks, 40% instream debris	60%	0	0	10	10	50	30	good salmon rearing, marginal spawning
	135-250	50-75% moderate	30% undercut banks, 10% instream debris	50%	0	0	10	30	40	20	excellent salmon spawning/rearing
	250-785	50-75% moderate	30% undercut banks, 10% instream debris	40%	0	0	10	30	50	10	excellent salmon spawning/rearing
10	785-890	50-75% moderate	30% undercut banks, 20% instream debris	40%	0	0	0	30	50	20	excellent salmon spawning/rearing
	890-1000	50-75% moderate	30% undercut banks, 10% instream debris	30%	0	0	10	20	40	30	excellent salmon spawning/rearing
	3.8 km d/s of corridor	50-75% moderate	50% undercut banks, 30% instream debris	50%	0	0	20	40	30	10	good salmon rearing, good spawning

Note: cl = clay
gr = gravel
si = silt
co = cobble
sa = sand
bo = boulder

(cont'd)

Table 6-11
Habitat Survey of Water Crossings

Number	from Corridor (m)	Stability	Cover	Pool	Substrate					Quality			
					cl	si	sa	gr	ba				
11	0-175	50-75% moderate	10% undercut banks, 40% instream debris	35%	0	0	0	10	20	60	10	moderate trout rearing poor spawning	
	175-200	50-75% moderate	10% undercut banks, 40% instream debris	35%	0	0	0	10	20	60	10	moderate trout rearing poor spawning	
	200-310	50-75% moderate	10% undercut banks, 40% instream debris	35%	0	0	0	10	20	40	30	moderate trout rearing poor spawning	
	310-690	50-75% moderate	10% undercut banks, 40% instream debris	35%	0	0	0	10	20	40	30	moderate trout rearing poor spawning	
	690-880	50-75% moderate	10% undercut banks, 40% instream debris	35%	0	0	0	10	20	60	10	moderate trout rearing poor spawning	
	880-1000	50-75% moderate	10% undercut banks, 40% instream debris	35%	0	0	0	10	20	60	10	moderate trout rearing poor spawning	
12	0-75	50-75% moderate	30% undercut banks, 40% instream debris	30%	0	0	0	0	30	50	20	excellent salmon spawning/rearing	
	75-200	50-75% moderate	30% undercut banks, 20% instream debris	30%	0	0	0	0	30	50	20	excellent salmon spawning/rearing	
	200-310	50-75% moderate	30% undercut banks, 35% instream debris	60%	0	0	0	0	30	50	20	good salmon rearing, marginal spawning	
	310-390	50-75% moderate	30% undercut banks, 20% instream debris	60%	0	0	0	0	30	50	20	good salmon rearing, marginal spawning	
	390-480	75-100% stable	5% undercut banks, 20% instream debris	10%	0	0	0	10	30	40	20	excellent salmon spawning	
	480-560	75-100% stable	5% undercut banks, 20% instream debris	10%	0	0	5	35	50	20	excellent salmon spawning		
	560-785	50-75% moderate	30% undercut banks, 10% instream debris	60%	0	0	0	10	30	50	10	excellent salmon spawning/rearing	
	785-1000	50-75% moderate	30% undercut banks, 10% instream debris	50%	0	0	0	10	20	40	30	excellent salmon spawning/rearing	
	14	0-108	50-75% moderate	5% undercut banks, 40% instream debris	80%	0	0	0	20	40	30	20	excellent salmon spawning/rearing
		108-208	high cliff to west	5% undercut banks, 40% instream debris	60%	0	0	0	0	10	30	60	excellent salmon rearing
208-350		high cliff to west	5% undercut banks, 40% instream debris	60%	0	0	0	20	40	30	20	excellent salmon spawning/rearing	
350-485		high cliff to west	5% undercut banks, 40% instream debris	60%	0	0	0	20	40	30	20	excellent salmon spawning/rearing	
485-535		high cliff to west	5% undercut banks, 40% instream debris	90%	0	0	0	20	40	30	20	good salmon rearing, marginal spawning	
535-700		0-50% unstable	5% undercut banks, 40% instream debris	30%	0	0	0	20	40	30	20	good salmon rearing, marginal spawning	
700-850		50-75% moderate	5% undercut banks, 40% instream debris	60%	0	0	0	20	40	30	20	excellent salmon spawning/rearing	
850-1000		50-75% moderate	5% undercut banks, 40% instream debris	70%	0	0	0	20	40	30	20	excellent salmon spawning/rearing	
17		0-75	75-100% stable	30% undercut banks, 10% instream debris	60%	0	0	0	0	30	50	20	excellent salmon spawning/rearing
		75-150	50-75% moderate	30% undercut banks, 10% instream debris	50%	0	0	0	0	30	50	20	excellent salmon spawning/rearing
	150-350	75-100% stable	30% undercut banks, 10% instream debris	20%	0	0	0	0	30	50	20	excellent salmon spawning/rearing	
	350-485	50-75% moderate	30% undercut banks, 10% instream debris	40%	0	0	0	0	30	60	10	excellent salmon spawning/rearing	
	485-535	50-75% moderate	30% undercut banks, 10% instream debris	20%	0	0	0	0	30	60	10	excellent salmon spawning/rearing	
	535-750	0-50% unstable	30% undercut banks, 10% instream debris	30%	0	0	0	0	30	60	10	excellent salmon spawning/rearing	
	750-850	0-50% unstable	30% undercut banks, 10% instream debris	30%	0	0	0	0	30	60	10	excellent salmon spawning/rearing	
	850-1000	0-50% unstable	30% undercut banks, 10% instream debris	60%	0	0	0	0	30	50	20	excellent salmon spawning/rearing	

Crossing 3 is over Tillits Brook. This crossing is less than four metres wide at the approximate centerline of the proposed highway crossing. The substrate at this crossing also has a high percentage of sand and silt, eliminating potential spawning by salmonids. Extensive beaver development through this area has eliminated the potential for significant salmonid habitat and likely resulted in significant barriers to fish migration. The banks of the river are approximately 0.1 metres high and moderately erodible. The approaches to the river are shallow gentle slopes characteristic of a flood plain. Only common non-salmonid fish species were caught during electrofishing.

6.4.4.2 West Branch Wallace River

The proposed alignment crosses four small unnamed tributaries of the West Branch Wallace River (Crossings 4 to 7). The route also crosses Emery Meadows which drains into the West Branch Wallace River. However, this crossing is described under 'Wetlands' in Section 6.5.3.

Crossing 4 is less than three metres wide at the approximate centerline of the proposed alignment. The substrate has a high percentage of sand and silt and only a small amount of riffle habitat making it marginal salmonid habitat. The banks of the river are approximately 0.2 metres high and moderately stable; the approaches to the river are shallow gentle slopes characteristic of a flood plain. Juvenile Atlantic salmon, speckled trout and common non-salmonid fish species were caught during electrofishing.

Crossing 5 is less than three metres wide at the approximate centerline of the proposed alignment. The substrate has a high percentage of gravel and sand and, combined with poor riffle habitat, provides only marginal rearing area for salmonids. The banks of the river are approximately 0.3 metres high and moderately stable; the approaches to the river have a shallow gentle slope characteristic of a flood plain. Juvenile Atlantic salmon, speckled trout and common non-salmonid fish species were caught during electrofishing.

Crossing 6 is less than three metres wide at the approximate centerline of the proposed highway crossing. The substrate has a high percentage of cobble and boulders and, combined with good riffle habitat, provides potentially good spawning habitat for Atlantic salmon. The banks of the river are approximately 1.3 metres high and moderately stable; the approaches to the river are shallow gentle slopes. Juvenile Atlantic salmon, speckled trout and common non-salmonid fish species were caught during electrofishing.

Crossing 7 is less than two metres wide at the approximate centerline of the proposed highway crossing. The substrate has a high percentage of boulders and a steep gradient, providing little if any spawning area for salmonids. The banks of the river are approximately 0.1 metres high and moderately stable. The western bank is a steep treed slope approximately 10-15 metres high. Speckled trout and common non-salmonid fish species were caught during electrofishing.

6.4.4.3 Portapique River

Crossings 8 to 10 are within the Portapique River watershed. In addition to crossing the main river, the proposed alignment crosses two small tributary streams. Crossing 8 is over a intermittent drainage channel. This unnamed tributary to Gleason Brook does not provide significant fish habitat, but juvenile Atlantic salmon, speckled trout and other common non-salmonid fish species were caught during electrofishing in Gleason Brook 500 metres downstream of this crossing. While there is no significant fish habitat at the crossing, Gleason Brook a short distance downstream does contain excellent salmon spawning habitat.

Crossing 9 is over the main Portapique River about 17 kilometres upstream of its mouth. This crossing is about six metres wide at the approximate centerline of the proposed alignment, with substrate composed largely of cobble and gravel over bedrock ledge. Cobble predominates in the substrate throughout the one kilometre wide corridor. Pools predominate in the lower 135 metres of the corridor section, providing good salmon rearing but marginal spawning. The remainder of the corridor has alternating pool and riffle

habitat, providing excellent areas for salmon spawning and rearing. The banks of the river are approximately 0.3 metres high and moderately stable; the approaches to the river are moderately steep (15° - 30°) treed slopes. Speckled trout and other common non-salmonid fish species, but no salmon, were caught during electrofishing. The absence of salmon in the electrofishing catch may have been due to the high flows at the time of the survey; there are no barriers to fish passage and Gleason Brook about 500 metres downstream of this crossing had large numbers of juvenile Atlantic salmon.

Crossing 10 is over Matheson Brook, less than one kilometre from the head of its watershed. The crossing site was not easily accessible and thus the stream was examined four kilometres downstream. In this section of stream, gravel and cobble predominated in the substrate and good salmon spawning and rearing habitat was available. Juvenile salmon, speckled trout and other common non-salmonid fish species were caught during electrofishing in this section. While the crossing site was not observed, it is likely that good trout habitat exists and some salmon habitat may also be present.

6.4.4.4 Great Village River

Five crossings occur within the Great Village River watershed. Crossings 11 to 13 and 15 are over tributaries to Great Village River; crossing 14 is over the main stem of the river.

Crossing 11 is over Spencer Brook, which becomes Cumberland Brook. The crossing is less than two metres wide at the approximate centerline of the alignment. The substrate throughout the corridor is coarse, with numerous boulders, and the gradient is steep. The section of stream within the corridor provides moderate trout habitat with only small pockets of possible spawning habitat. The banks of the river are approximately 0.1 metres high and moderately stable. The approaches to the banks are steep treed slopes (25° - 35°) approximately 10 to 15 metres high. Speckled trout and black-nosed dace were caught during electrofishing.

Crossing 12 is over Cumberland Brook about two kilometres upstream of its confluence with the Great Village River. This crossing is about six metres wide at the approximate centerline of the alignment. Cobble substrate is prevalent throughout the corridor providing many areas of excellent spawning habitat. Some of the best spawning habitat is located at the proposed crossing location, while only marginal spawning habitat is located between 100 and 300 metres downstream. The banks of the stream are approximately 0.3 metres high; the east bank is moderately stable while the western bank is a steep treed slope (45° - 60°) approximately 20 to 30 metres high. Juvenile salmon, speckled trout and common non-salmonid fish species were caught during electrofishing.

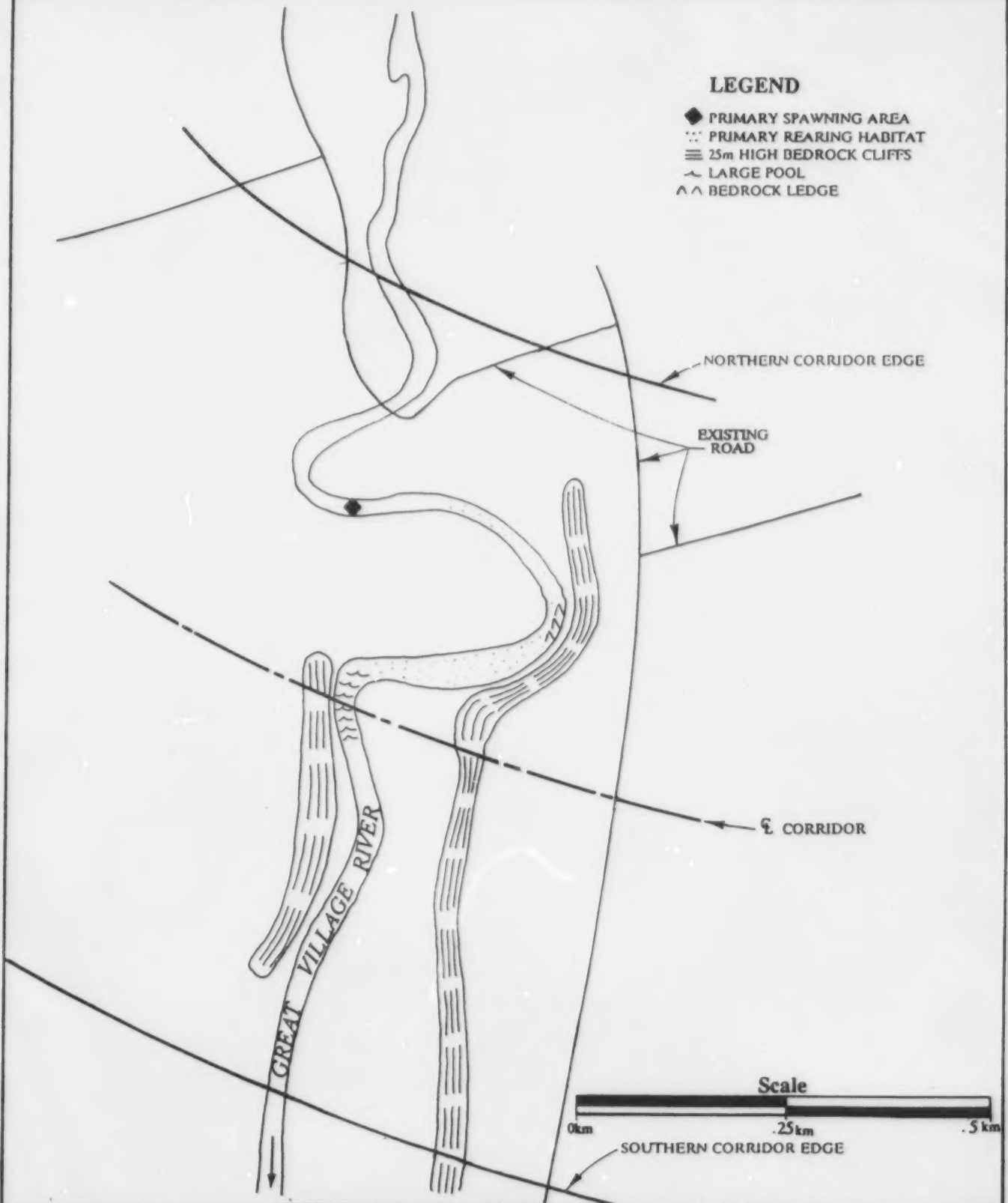
Crossing 13 is over Moose Brook, a poorly defined seasonal drainage swale. This brook does provide some marginal salmon habitat approximately seven kilometres downstream of the crossing. There was insufficient water to electrofish at this site.

Crossing 14 is over the main steam of the Great Village River, approximately three kilometres upstream of the head of tide. This crossing is about 25 metres wide at the approximate centerline of the proposed alignment. Substrate throughout the corridor is relatively consistent with about 30 percent cobble and frequent bedrock ledge. Excellent spawning and rearing habitat exists throughout most of the corridor, but a large pool is present at the crossing. This pool is about 50 metres long with a well defined run leading into it. At the crossing, the eastern bank is about 1.5 metres high and moderately stable; the western bank is a vertical bedrock cliff approximately 25 to 30 metres high (Figure 6-12). High bedrock cliffs are present on one bank or the other throughout the corridor. Juvenile salmon, speckled trout and common non-salmonid fish species were caught during electrofishing. Additional information on the proposed Great Village River crossing is included in Appendix 2.

Crossing 15 is over Peppard Brook, about three kilometres upstream of its confluence with the Great Village River. At the crossing, this brook is a poorly defined seasonal drainage swale. Peppard Brook drains into a artificially flooded wetland/pond

LEGEND

- ◆ PRIMARY SPAWNING AREA
- ⋯ PRIMARY REARING HABITAT
- ≡ 25m HIGH BEDROCK CLIFFS
- ~ LARGE POOL
- ^^ BEDROCK LEDGE



**NOLAN, DAVIS
& ASSOCIATES**

FIGURE 6-12
GREAT VILLAGE RIVER
CROSSING

JANUARY 1992

H21462

recreational area that was historically stocked with speckled trout. There was insufficient water for electrofishing at the crossing.

6.4.4.5 Folly River

Crossing 16 is over the main Folly River approximately one kilometre upstream of the head of tide. This crossing is approximately 35 metres wide. Extremely high water conditions prevented field team members from conducting a survey of the proposed alignment corridor. Available information suggests that the corridor provides excellent salmon spawning and rearing habitat. Electrofishing was conducted in a small tributary less than 500 metres upstream of the proposed corridor centerline; juvenile salmon, speckled trout and common non-salmonid fish species were caught.

6.4.4.6 Debert River

Crossing 17 is over the main Debert River approximately 1.5 kilometres upstream from the head of tide. This crossing is about 34 metres wide at the approximate centerline of the proposed alignment. Cobble and gravel substrate predominates throughout the corridor. Pool and riffle sequences are common and the tree canopy is open providing abundant high quality spawning and rearing habitat for salmon. The banks of the river are approximately one metre high and moderately stable; the approaches to the river are shallow gentle slopes characteristic of a flood plain. Juvenile salmon, speckled trout and common non-salmonid fish species were caught during electrofishing.

6.5 Terrestrial Environment

6.5.1 Habitat and Wildlife

Habitat types within the proposed highway corridor were identified by interpretation of the available 1:10,000 colour aerial photography (1985), 1:20,000 black and white photography (1991), and 1:63,000 colour infrared photography. Habitat types were based on species composition, height, density, condition, successional status and ground plant associations. These habitat types were transferred to 1:10,000 orthophoto base maps of the

highway corridor. Field surveys were conducted in October of 1991 to verify the habitat type and boundaries, and to check for the presence of unique plants.

6.5.1.1 Overview

Biophysical districts are areas that share physical, climatic and biological characteristics at a broad scale. The proposed highway corridor crosses three biophysical districts: the Oxford, Cobequid Mountains, and Windsor-Truro districts (Loucks, 1962). The Oxford district, from Thomson Station to Westchester Station, consists of a complex of well-drained rolling hills and large expanses of poorly-drained lowland flats. The Cobequid Mountain district, from Westchester Station to Lornevale, consists of a flat-topped mountain range and side slopes. The Windsor-Truro district, from Lornevale to Masstown, comprises a lowland surrounding the Cobequid Bay.

Although forests always change and do not truly reach a "climax" stage, this term will be used to represent forests in which the species present are long-lived and continue to reproduce under their own shade. Forests progress through successional stages to a final climax stage that remains stable for relatively long periods of time. In Nova Scotia the following climax forest habitats exist:

- Sugar maple, yellow birch and beech in uplands;
- Spruce, hemlock and pine in lowlands; and
- Spruce, fir, maple and birch in coastal areas.

In flat, poorly-drained sites, a climax forest of balsam fir, white spruce, black spruce and larch is also common. The vegetation over most of the corridor has been affected by major forest fires and logging, primarily of softwoods. Climax stands of maple birch and beech exist within the corridor. Small mature forest stands of spruce and pine exist in portions of the corridor as well.

Figure 6-13 illustrates the basic vegetation zones along the corridor. The characteristics of each of these zones is described separately.

6.5.1.2 Pine and Wetlands

The initial 11 kilometres of the corridor passes through an area dominated by small wetlands and pine forest. Wetlands are described separately in Section 6.5.3. Pine forest habitat, composed of pure and mixed stands of white, red and jack pine, along with some red maple, aspen, black spruce and white birch, forms after a forest fire on moist to very dry sites. The pines seed quickly after an intense fire, particularly on sandy, gravelly, or rocky, dry soils. This is especially true of jack pines, which require a great amount of heat to open the seed cones. These pine forests are early to mid-successional stages that will likely progress to white pine, red spruce, hemlock forest association, provided fire or logging does not intervene. The originating fire also promotes the bracken fern-lambkill plant association which is almost always found under a pine forest. This association of ericaceous shrubs is normally only found in openings, because it cannot compete with the fall of acidic pine needles under a closed canopy. The acidity of the pine needle forest floor also limits the soil fauna and small mammal populations found in these forests; red squirrel, red-backed vole and cinerous shrew are frequently the only small mammals present. Bird life is also limited, with chickadees, warblers and juncos being the most common.

6.5.1.3 Shade-Intolerant Hardwood Hills

A small area of rounded, smooth-topped hills occurs in Kilometre Six of the proposed corridor. This well-drained area is characterized by intolerant hardwoods like red maple, white birch and aspen. As well, black and red spruce are found intermixed with the intolerant hardwoods. These forest stands are almost all in early successional stages, and represent regrowth following fire or logging.

This type of forest, although not particularly rare or valuable, provides habitat for a wide range of birds and animals.

6.5.1.4 Shade-Tolerant Hardwood Hills

Shade-tolerant hardwood hills occur on both sides of the Cobequids, between Kilometres 12 and 15 and Kilometres 21 and 25. These areas have a mix of softwood and



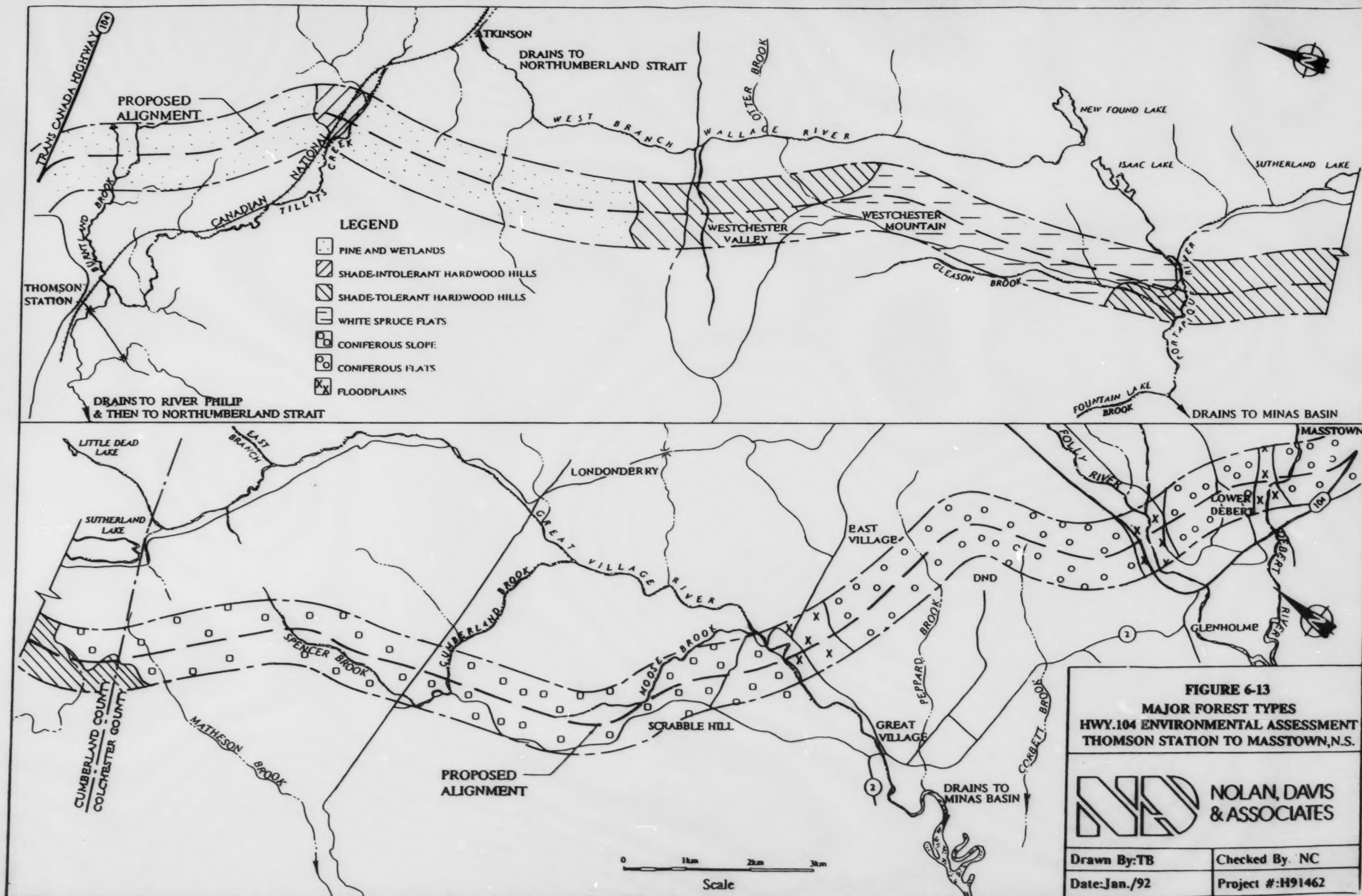


FIGURE 6-13
MAJOR FOREST TYPES
HWY.104 ENVIRONMENTAL ASSESSMENT
THOMSON STATION TO MASSTOWN, N.S.



**NOLAN, DAVIS
& ASSOCIATES**

Drawn By: TB

Checked By: NC

Date: Jan./92

Project #: H91462



hardwood stands, but climax hardwood stands, comprising sugar maple, yellow birch and beech, are the most common.

This sugar maple, yellow birch and beech forest composition is uncommon in Nova Scotia, making up five percent of the forests (NS Department of Natural Resources, unpublished data). It is also generally considered the most valuable wildlife habitat within the province because of its relatively high ecological diversity, providing microhabitats found in no other type of forest. These forests occur on well-drained, nutrient rich upland sites. In North America, Nova Scotia represents the northeastern limit of distribution for this forest type. This type of forest is relatively stable; under natural conditions, sugar, maple, yellow birch and beech continually replace each other, maintaining the general species composition. Shade tolerant conifers, such as red spruce and hemlock, may also become established in pockets during successional sequences.

Soils tend to be rich and support a diverse fauna. Understory trees, mainly striped maple and hop hornbeam are frequent. Ground vegetation in this habitat is the most diverse in the province. It is characterized by *Dryopteris* ferns, Christmas fern and clubmosses. Many rare and endangered plants may also be found over the range of this forest type. The hummocky terrain and rotting logs provide many micro habitats for insects, amphibians, reptiles and small mammals. Warblers and woodpeckers are common in the tree canopy.

6.5.1.5 White Spruce Flats

White spruce dominates the abandoned agricultural lands and coastal areas because of its ability to reproduce in open areas, where full sunlight and little competition exists for its development and because of its ability to withstand salt spray. These forests generally become dense and uniform, with abrupt transitions along their edges. White spruce stands are an early successional type because this spruce does not reproduce well under its own canopy. These stands are generally invaded by balsam fir, red spruce and shade-tolerant hardwoods.

Ground vegetation within white spruce stands is almost exclusively needle carpet and/or a moss layer. Mosses are restricted to a few species, predominately *Pleurozium schreberi*, *Dicranum* spp, *Hylocomium splendens*, and the liverwort, *Bazzania trilobata*.

Small mammal diversity in mature white spruce forest is lower than in other forest habitats. The age, density and area covered by white spruce forest will determine the species of wildlife found there. However, most commonly are found red squirrels, red backed voles and woodpeckers. These forests provide excellent cover for deer and rabbits, especially when adjacent to areas of good feeding. Young stands may provide habitat for foliage-gleaning birds such as kinglets and warblers. Various finches, such as the siskins and crossbills, feed on seed cones.

White spruce stands are most common between Kilometres 16 and 20, but white spruce occurs throughout most of the corridor south of Westchester Station.

6.5.1.6 Coniferous Slope

The southern slope of the Cobequids, from Kilometre 26 to 35, is dominated by spruce-fir, pine-maple, birch and spruce-fir-pine forests. Both of these are early successional forests developed as a result of logging and fire on moist to dry sites. Red spruce, fir and white pine dominate the upper canopy, with a minor association of red maple and white birch. A spruce-fir understory is usually present.

Soils in these forests are generally nutrient poor, with a limited soil fauna. Populations of small mammals are generally low. The bracken fern-lambkill plant association, including blueberry and bunchberry, dominates the ground cover. Small passerine and canopy birds are present in the upper canopy of the trees; warblers tend to be the most common birds in these forests.

6.5.1.7 Coniferous Flats

To the south of the Cobequids, between Kilometres 37 and 46, the topography flattens and black spruce-larch, black spruce-fir-maple, and spruce-fir forests dominate. These forests are the early successional stages of the climax spruce-hemlock-pine forests of lowland Nova Scotia. The black spruce, larch forest occupies poorly drained areas in and along the edges of swamps and bogs. The black spruce, balsam fir, red maple forest is found on wet to moist lowland sites, as well as peat-filled depressions or mineral wetlands with standing or gently flowing water. The spruce (black and/or red), balsam fir forest is a mid-successional forest resulting from the gradual drying up of the two previous habitats, or following logging of older coniferous forests.

The black spruce, larch forest is dominated by the moisture loving sphagnum mosses and sedges. The slightly drier spruce, fir-maple forest has a similar ground vegetation with the addition of the cinnamon fern. This type of forest stand also contains many shrubs and herbs not found in the spruce forests. The spruce, fir forest is similar to the white spruce habitat in that its ground vegetation is dominated by *Pleurozium schreberi*, *Dicranum* spp, *Hylocomium splendens*, and the liverwort, *Bazzania trilobata*. In natural openings or thinnings, a wood fern-wood sorrel plant association competes with the mosses. With the exception of the spruce, fir-maple forest, the soil fauna and small mammal populations are low in abundance and diversity, due to the acidic humus and lack of herbaceous plants. Red-backed voles, short-tailed shrews and red squirrels would be the most common small mammals. Birds found in this habitat would include warblers, sparrows, flycatchers, swallows, as well as the common nighthawk, spruce grouse and the blackbacked three-toed woodpecker.

6.5.1.8 Floodplains

Three significant floodplains are crossed by the corridor; these are associated with the Great Village, Folly and Debert rivers. Floodplains have rich soils derived from river-deposited sediments and are frequently developed for agriculture. Most of the floodplain area within the corridor is developed, but may still provide important seasonal

feeding habitat for wildlife. None of the floodplains within the corridor contain intervalle habitat.

6.5.1.9 Rare Forest Species Associations

While most of the corridor is covered by spruce-fir forest common throughout Nova Scotia, some types of forest stands within the corridor are rare, i.e., constitute less than one percent of the provinces forests. Table 6-12 provides a list of these uncommon forest associations and their location within corridor kilometres.

The pine forest associations common between Kilometre 2 and 9, and the maple-birch-beech forest association found in Kilometres 14 and 21 to 25, are the most significant of these rare forest types. Regionally jack pine is fairly common in the southwestern section of Cumberland County. It represents a relatively unproductive forest, when compared with other forest types found in Nova Scotia. It is a forest in the early stages of succession that will likely be gradually replaced by black spruce, red spruce and white pine. In comparison, the sugar maple, yellow birch and beech forest type represents a stable, productive forest, rich in ecological diversity and rare throughout the province. In addition, these climax hardwood stands provide essential habitat for rare species like the eastern redback salamander (*Plethodon cinereus*) in the all-red (erythristic) phase (Gillen, 1984).

Individual rare plants or animals were not observed during field surveys and are unlikely to occur within the proposed corridor. The ground association of all major forest types were field checked and unusual habitat that would likely contain rare or endangered plants was not observed. Many species of rare plants are found within intervalle habitat and this type of habitat does not occur within the corridor.

TABLE 6-12**Uncommon Forest Associations within the Proposed Highway Corridor**

<u>Species Association</u>	<u>Ground Associations</u>	<u>Kilometre of Occurrence</u>
white spruce, yellow birch	ferns - maples	18
spruce, red pine	bracken fern - lambkill humus - moss	7 - 9
spruce, jack pine	bracken fern - lambkill humus - moss	2 - 9
white spruce, spruce, balsam fir	humus - moss	16, 29, 33 - 34, 43, 45
white spruce, balsam fir, red maple	humus - moss wood fern - wood sorrel	32, 35
sugar maple, yellow birch beech	ferns - maples	14, 21 - 25
red pine, jack pine	bracken fern - lambkill	7
spruce, balsam fir, sugar maple	humus - moss wood fern - wood sorrel	22, 27

note: Although some of the individual species are common, such as white spruce, spruce (red and black spruce), balsam fir and red maple, the particular associations listed are uncommon in Nova Scotia.

6.5.2 Game, Furbearers and Birds

Habitat mapping and wildlife inventories for Nova Scotia are incomplete and therefore, species distributions must generally be based on associations with general forest and other habitat types. Overall, the Cobequids and their north border areas contain typical Nova Scotia habitats for furbearers, forest birds, raptors, waterfowl, and moose and deer. On the whole, they provide average quality wildlife habitats and harvests, with little

TABLE 6-13
Listing of Rare and Endangered Plant

Species	Common Name	Habitat	Study Area Comments
<i>Achillea borealis</i>	yarrow	Br specialized variety; adapted to alpine habitats in Cobequide	dies off in August
<i>Asplenium viride</i>	green spleenwort	MBB, ME, SHP moist cliffs near waterfalls; one of rarest plants in NS; found on Moose River in western Cobequide; primarily found in CB, where it is protected in the CB Highlands National Park	dies off in September
<i>Calamagrostis neglecta</i>	type of grass	F, TB, etc; bogs, swales, marshes, lakesides; collected near Amherst	dies off by early fall
<i>Carex adusta</i>	sedge	RR, GP, etc. disturbed rocks by roadsides, etc.	dies off in September
<i>Carex tuckermanni</i>	sedge	F; collected in Hants and Cumberland Counties	dies off in August
<i>Caulophyllum thalictroides</i>	blue cohosh	MBB, ME, especially in intervals	predominantly in ME - none in study area;
<i>Cystopteris fragilis</i>	fragile fern	MBB, ME, SHP; moist areas in woods; damp crevices or ledges on cliffs and sinkholes; may be abundant, but difficult to identify	dies off in September
<i>Dicentra cucullaria</i>	Dutchman's breeches	MBB, ME	dies off in early June
<i>Dryopteris fragrans</i>	fragrant fern	MBB, ME, SHP dripping or protected cliff crevices in ravines along rivers throughout Cobequide	few, if any appropriate habitats available; dies off in September
<i>Eriophorum gracile</i>	cotton grass	F, TB; probably rarest of genus in NS; extirpated, endangered or rare in mid-West USA	mainly a coastal species; habitat unlikely in study area. dies off in July,
<i>Erythronium americanum</i>	dog's tooth violet	MBB, ME, especially in intervals	no intervals habitat; dies off in June
<i>Festuca obtusa</i>	nodding fescue	MBB, ME, especially in intervals	no intervals habitat; dies off in July
<i>Gallium boreale</i> L. var. <i>intermedium</i>	bedstraw	OF, Ag, etc. woodland edges, grassy places	dies off in August
<i>Lilium canadense</i>	Canada lily	MBB, ME, especially in intervals; very rare	no intervals habitat; dies off in early August
<i>Millium effusum</i> var. <i>clavatum</i>	type of grass	MBB, ME rich alluvial hardwoods	dies off in August Cont'd

TABLE 6-13 (Cont'd)
Listing of Rare and Endangered Plant

Species	Common Name	Habitat	Study Area Comments
<i>Oryzopsis canadensis</i>	type of grass	WS, OF, P dry & barren soils, dry woods; found in Cumberland & central Colchester	
<i>Platanthera macrophylla</i>	tinged orchid	MBB, ME rich hardwoods	dies off in early August
<i>Polygala sanguinea</i>	milkwort	A, WS, OF; fairly common poor/acid field, open bush	dies off in October
<i>Thlasia cordifolia</i>	false milkwort	MBB, ME, especially in intervals	no interval habitat; dies off in July
<i>Trillium erectum</i>	purple trillium	MBB, ME fairly abundant when appropriate habitat available	dies off in early June
<i>Tricelium aurantiacum</i>	feverwort	MBB, ME, especially in intervals	no interval habitat; dies off in October
<i>Verbena hastata</i>	blue vervain	river bottom with rich muddy soil collected in Wallace River area	dies off in September

Nomenclature and habitat descriptions supplied by N.S. Museum. Study area comments from field investigations, mapping, & Fernald (1958), Roland (1988).

Comments usually refer to the disappearance of the flowering parts of plants, but in many cases can refer to death of whole plant. Very few herbaceous plants are evergreen, and thus have disappeared by the onset of early fall frosts and leaf-fall.

For legend, see Table A2-3, Appendix 2

to differentiate them from other similarly remote parts of the Province.

In general, there appears little to set this particular study area apart from the rest of the Cobequids. The primary wildlife issue identified is that of accessibility; the proposed alignment does open up areas that are currently awkward or impossible for the casual visitor to reach. This increased accessibility would undoubtedly lead to greater people-pressures on many areas that are currently undisturbed.

6.5.2.1 Game and Furbearers

Deer are plentiful in many parts of the study area, particularly to the east and northwest of the Wentworth Valley. Harvesting statistics are available only by county. Large numbers of deer are harvested annually in both Cumberland and Colchester counties; for example, in 1989 more deer were taken in Colchester than any other county. In 1990 approximately 2300 deer were harvested in the two counties out of a provincial total of 16,200. Deer overwinter primarily on the south-facing slopes of the Cobequids, between elevation 75 metres and 150 metres. Parts of the corridor contain mature softwood that could provide good overwintering areas for wildlife, especially where adjacent stands of ground hardwood and mixed stands occur to provide a feeding area for many wildlife species.

Moose have not been harvested on mainland Nova Scotia since 1985. While statistics are not available, the Cobequids are regarded as the best moose habitat on the mainland. Moose survive best when they overwinter away from deer, which carry a brain-worm parasite, *parelaphostrongylus tenuis*. Although harmless to deer, *p. tenuis* can be fatal to moose. Above approximately 150 metres of elevation, deer are hampered by deep snow and more severe weather conditions. The weather and "moose sickness" factors thus cause separation of winter habitat, with moose common through the Cobequids above elevation 150 metres. While significant numbers of moose have not been reported near the proposed alignment, signs of moose were observed during field surveys in the northwestern part of the corridor.

Furbearers are also harvested in many parts of the study area. While muskrat and beaver are important in Cumberland and Colchester counties, trapping locations are not thought to be concentrated near the proposed alignment. The northwest section of the alignment crosses numerous wetlands and provides habitat for muskrat, beaver and the like; however, there is little known trapping activity in the area. Cumberland and Colchester were the only counties in which the fisher, a protected species, was reported taken (presumably by mistake) in 1990/91. The counties also account for significant harvests of several other furbearers including fox, raccoon, and coyote. Lesser numbers of otter, bobcat, squirrel, weasel, and skunk were also taken.

Cumberland and Colchester are important grouse areas; in 1990, more grouse were taken in Cumberland County than in any other county, and the two counties represented 18 percent of the Nova Scotian total. As well, approximately 11 percent of the snowshoe hare and ring-necked pheasant kill occurred in Cumberland and Colchester counties. The variety of wildlife and birds in the study area also forms an important recreational resource, helping to attract birdwatchers, photographers, hikers, and outdoor enthusiasts to the region.

6.5.2.2 Birds

Bird species within the study area were identified primarily by an examination of the data in the Atlas of Breeding Birds of the Maritime Provinces (Erskine, 1992) a review of habitat associations from Birds of Nova Scotia (Tufts, 1986) and interviews with knowledgeable birders, supplemented by some field observation by members of the study team. Data within the Atlas are arranged by ten kilometre squares according to the standard UTM grid. Data were examined for the squares through which the route passes, as well as for squares immediately to the east or west, if they contained similar habitat types. Data for seven squares were examined, and compiled in Table 6-14.

The MBB Atlas estimates species abundance per square on a logarithmic scale from one - six; where one represents an estimated population of one pair, two, from

TABLE 6-14

Results of Bird Survey

Area observed in:		West-chester	Jackson/Sugarloaf	West-chester	Lanesville	Folly Mt.	Glanville
SPECIES	Millvale	Station	Mountain	Mountain			
Order Gaviformes, Family Gavidae							
Common Loon			2	3	2	2	
Order Podicipediformes, Family Podicipedidae							
Pied-Billed Grebe							2
Order Ciconiiformes, Family Ardeidae							
American Bittern						2	
Great Blue Heron				2			
Order Anseriformes, Family Anatidae							
Wood Duck		x		x			2
Green-Winged Teal							2
American Black Duck*		x	2	3	2		3
Mallard				2			
Blue-Winged Teal							2
American Wigeon							2
Ring-Necked Duck							x
Common Merganser			2				
Hooded Merganser		2					
Order Falconiformes, Family Accipitridae							
Osprey			2			1	
Bald Eagle	1		1	x			x
Northern Harrier*	3		2			2	2
Sharp-Shinned Hawk						2	2
Northern Goshawk			1			1	
Broad-Winged Hawk							2
Red-Tailed Hawk			2	2	2	1	2
American Kestrel		2	2	2		2	2
Order Galliformes, Family Phasianidae							
Gray Partridge							3
Ring-Necked Pheasant	3		2	x	2	2	3
Spruce Grouse		3	3	3		3	3
Ruffed Grouse*	3	3	3	3	3	3	3
Order Gruiformes, Family Rallidae							
Sora Rail							2
Order Charadriiformes, Family Scolopacidae							
Killdeer	3		3		2	3	3
Spotted Sandpiper	2		3	x	2	3	2
Common Snipe			3	3	3	3	3
American Woodcock	3		3	x			
Order Columbiformes, Family Columbidae							
Mourning Dove				x		2	2
Rock Dove*	3	3	3		3	3	4
Order Galliformes, Family Strigidae							
Great Horned Owl	2	2	2	2	2	2	2
Barred Owl			2	2	2	2	2
Saw-Whet Owl			2				x
Order Apodiformes, Family Apodidae							
Common Nighthawk*			2	x		2	
Chimney Swift	3		3				
Family Trochilidae							
Ruby-Throated Hummingbird	3	3	3	2		2	
Order Coraciiformes, Family Alcedinidae							
Belted Kingfisher*	2	2	2	x	2	2	2

(cont'd)

TABLE 6-14 (Cont'd)

Results of Bird Survey

Area observed in:

Area observed in:		West Chester	Jackson/ Sugarloaf Mountain	West Chester			
SPECIES	Millvale	Section	Mountain	Mountain	Lebanon	Port Hope	Chambersburg
Order Piciformes, Family Picidae							
Yellow-Bellied Sapsucker	3			x		2	2
Downy Woodpecker	3	3	3	x	3	3	
Hairy Woodpecker*	3	3	3	x	3	3	3
Black-Backed Woodpecker				x		2	x
Northern Flicker*	3	3	3	3	3	3	3
Pileated Woodpecker		3	2	2	3	2	3
Order Passeriformes, Family Tyrannidae							
Olive-Sided Flycatcher	3				3	3	2
Eastern Wood Pewee	3	3			3	3	3
Alder Flycatcher	3	4	3		3	3	4
Least Flycatcher	3	2	2	2	2	2	
Eastern Kingbird	2	2					x
Family Tyrannidae							
Horned Lark							x
Family Hirundinidae							
Tree Swallow*	3	4	3	3	3	4	3
Bank Swallow*	3	3	3			3	3
Cliff Swallow	3	3	3				
Barn Swallow	4	4	3	3	3	4	4
Family Corvidae							
Gray Jay		3	3	3		x	3
Blue Jay*	3	3	3	2	2	3	3
American Crow*	3	3	3	3	3	3	3
Common Raven*	2	3	2	2	2	2	2
Family Paridae							
Black-Capped Chickadee*	4	4	4		3	4	3
Boreal Chickadee*		3	3	3	3	3	3
Family Sittidae							
Red-Breasted Nuthatch*	4	4	4	3	3	3	3
Family Certhiidae							
Brown Creeper				x			
Family Troglodytidae							
Winter Wren		3	4	3	3	3	
Family Muscicapidae							
Golden-Crowned Kinglet*	4	4	4	4	4	4	4
Ruby-Crowned Kinglet*	3	3	3	3	3	3	3
Veery	3	3	2	2	2	3	
Swainson's Thrush*		3	3	3	3	3	3
Hermit Thrush	3	4	3	3	3	3	3
American Robin*	4	4	4	4	4	4	4
Family Mimidae							
Gray Catbird	2	3	2	2		x	2
Family Bombycillidae							
Cedar Waxwing	3	4	4	3	3	3	3
Family Sturnidae							
Starling*	4	3	3	3	3	4	4
Family Vireonidae							
Solitary Vireo	3	3	3	3	3	3	3
Red-Eyed Vireo	3	4	4	4	4	4	4

(cont'd)

TABLE 6-14 (Cont'd)

Results of Bird Survey

Area observed in:

Area observed in:		West-chester	Jackson/ Sugarloaf	West-chester			
SPECIES	Millvale	Station	Mountain	Mountain	Lanesville	Folly Mts.	Gladesville
Family Emberizidae							
Tennessee Warbler	3	3	3	3	3	3	3
Nashville Warbler	3	3	3		3	x	3
Northern Parula Warbler	3	3	3	3	3	3	3
Yellow Warbler		4	3	3	3	3	4
Chestnut-Sided Warbler	3	3	3		3	3	
Magnolia Warbler	3	3	3	4	3	3	3
Cape May Warbler			2	2	2	2	2
Yellow-Rumped Warbler*	3	3	3	3	3	3	3
Black-Throated Green Warbler		3	3	3	3	3	3
Blackburnian Warbler	3	3	3		3	3	3
Palm Warbler	3			3		x	2
Bay-Breasted Warbler	3		2		2	2	
Blackpoll Warbler			3				
Black-and-White Warbler	3	3	3	3	3	3	3
American Redstart	4	4	4	4	4	4	3
Ovenbird	4	4	3	3	3	3	4
Northern Waterthrush			3	3	2	2	2
Mourning Warbler		2	3	2	3		3
Common Yellowthroat*	4	4	4	4	4	4	4
Wilson's Warbler						2	
Canada Warbler	3	3	3	3	2		2
Rose-Breasted Grosbeak	3	3	3	2	2	x	3
Indigo Bunting							1
Chipping Sparrow	4	4	3	2	3	3	3
Vesper Sparrow	3	3	3	3			
Savannah Sparrow	4	4	4	3	4	4	4
Sharp-Tailed Sparrow							3
Song Sparrow	4	4	4	4	4	4	4
Lincoln's Sparrow	3		3	3	3	3	
Swamp Sparrow			3	2	3		3
White-Throated Sparrow*	4	4	4	3	3	3	3
Dark-Eyed Junco*	3	3	4	4	4	4	4
Bobolink	3	3	3		3	3	4
Red-Winged Blackbird*	x	4	3	x	2	3	4
Rusty Blackbird		x		2		x	
Common Grackle	4	4	3	2	2	3	3
Brown-Headed Cowbird	2		2	2		2	2
Family Fringillidae							
Pine Grosbeak				x		2	
Purple Finch	3	3	3	3	3	3	
Red Crossbill	2						
White-Winged Crossbill*	4	3	4		3	3	3
Pine Siskin	3	3	3	3	3	3	3
American Goldfinch*	4	3	3	3	3	4	3
Evening Grosbeak	3	3	3	x		3	
Family Passeridae							
House Sparrow	3	3	3		3	4	4

NOTES: Majority of data courtesy of Maritime Breeding Bird Atlas, (1991); observations for the Atlas were conducted by knowledgeable volunteers. The presence of species marked with * was confirmed by study team field visits. 4 indicates most abundant. Shading indicates areas passed through by the proposed highway and most abundant species within these areas.

two - ten pairs, three from 11- 100, four from 101-1,000, five from 1,001 to 10,000, and six over 10000 pairs. A ranking of three or four means that a species is relatively common; no sixes have been found in the Maritimes, and only a very few fives. No species that Tufts ranks as rare has been observed in the study area, though some forest habitats within the corridor would support the rare merlin and long-eared owl.

Some breeding species that Tufts estimates to be uncommon in summer have high Atlas abundance ratings of three or four, which would seem to indicate that they may be more common in the study area than in the province as a whole. They include: spruce grouse, pileated woodpecker, gray jay, winter wren, solitary vireo, blackburnian warbler, mourning warbler, vesper sparrow, lincoln's sparrow, and evening grosbeak. Most of these prefer expanses of unbroken forest habitat of the kind provided in some parts of the study area.

The proposed corridor provides habitat for a wide range of breeding birds; there are, however, no unique habitat pockets nor extremely rare species in the affected corridor. Some of the species observed are found in more than one habitat type; for example, the dark-eyed junco is widespread in both mixed coniferous and deciduous woods, as well as near settled areas and along disturbed corridors, such as roads. Others, like the mourning warbler, which is seldom found outside of dense deciduous undergrowth, have specific habitat preferences and associations. The majority of recorded species are found throughout the study area.

In general, ruffed grouse, great horned owls, ruby-throated hummingbirds, cedar waxwings, jays, crows, ravens, chickadees, nuthatches, and vireos are widespread along the route, as are a variety of species of flycatchers, swallows, woodpeckers, kinglets, thrushes, warblers, and finches.

In particular, the pine and wetlands areas, found in the northern section of the route provide habitat for such species as alder flycatchers, some waterfowl, bank and cliff

swallows, veeries, and pine siskins.

Climax hardwood lands remote from human settlement are preferred by barred owls, northern goshawks, pileated woodpeckers, and most red-eyed vireos. Spruce grouse, yellow-bellied fly catchers, rusty blackbirds, winter wrens and palm warblers are associated with damp, poorly drained coniferous flats, while a wide variety of warblers, sparrows, kinglets, and thrushes like coniferous slopes.

The Cobequids in general provide good raptor nesting habitat, although Lands and Forests biologists have not identified any eagle nests in the study area. A number of hawks, including the red-tailed hawk, are known to be present in the area. On the whole, the corridor provides productive bird habitat, though there appears little to set it apart from the rest of the Cobequids area. If anything, large portions of this corridor have already been disturbed, in comparison to adjacent areas to the east and west.

6.5.3 Wetlands

Wetlands were mapped using available 1:10,000 colour aerial photography (1985) and 1:20,000 black and white aerial photography (1991). Habitat value for these wetlands was based on the Nova Scotia Wetlands Atlas. Five wetlands in the northwest corner of the alignment were surveyed in detail in early October. A minimum of three randomly located five metre by five metre plots were sampled in each wetland. All species present were recorded, with relative cover values for each. Plants observed but not contained within the plots were also recorded (see Section 6.5.3.4.).

6.5.3.1 Overview

The first 11 kilometres of the proposed alignment contains 71 hectares, or 61 percent, of the wetland habitat within the corridor. This northwestern area includes fens and treed bogs with small scattered flat basin bogs. These wetlands primarily form the headwaters of tributaries to the River Philip, although some wetlands further south feed the West Branch Wallace River. While numerous, these wetlands do not provide especially

valuable waterfowl habitat, none are rated as significant for wildlife in the Nova Scotia Wetland Atlas. At the same time, large numbers of beaver were observed throughout this area. The primary value of this wetland area is probably associated with their influence on stream flows and water quality; wetlands serve to dampen floods and aid in water purification and recharge.

6.5.3.2 Bogs

A bog is a mossy peat-filled wetland formed either from the infilling of a lake or pond or in the shallow depressions on undulating rocky topography. Bogs contain layer upon layer of acidic sphagnum moss (peat), resulting from continual accumulations of organic matter; they may have trees or be treeless.

Bogs, mainly treed bogs, are concentrated in the northwest portion of the corridor, between Thomson Station and Westchester Station. Bogs in this area occur in the headwaters of the River Philip and West Branch Wallace rivers. Most of these are small, but a large one (approximately 16 hectares), located near Atkinson within Kilometre 8 of the corridor, is bisected by the proposed alignment. There is also a large treed bog (approximately 13 hectares) within the Great Village River floodplain, but the proposed alignment passes south of this bog.

The bog surface is sometimes flat, but more often it is raised toward the center. The dominant peat material is sphagnum moss, with sedge peat contributing a minor amount to the bog's structure. During early bog development, the surface of the bog may take on a hummocky appearance because of the differential growth rates of the various sphagnum species. These hummocks may eventually coalesce to form ridges with an enclosed depressional area, which may form a pond. Drier bog surfaces can be colonized by *Sphagnum capillaceum*, *S. fascum*, and a variety of mesophytic vascular plants and lichens, particularly *Cladina sangifesa* and *C. stellaris*. The lichens, dwarf larch, dwarf black spruce and ericaceous shrubs can become well established over time.

Many species of orchids bloom on bogs during June and July including the paper-white (*Habenaria blephariglottis*), swamp-pink (*Pogonia ophioglossoides*), grass-pink (*Calopogon pulchellus*), and bog-pink (*Arethusa bulbosa*). The grass-pink and bog-pink orchids are widespread in Nova Scotia, but relatively rare. The October field surveys were unable to confirm the presence of any of these orchids.

Productivity of bogs is generally low due to exposure and high acidity. Many species of amphibians (e.g., the four-toed salamander) and reptiles (e.g., garter snakes) occur in bog habitat, especially those with ponds. Many mammals and birds use bog habitat, but few are full-time residents.

6.5.3.3 Fens

A fen is a sedge-peat wetland along lake edges or river bands; sedges and grasses are the predominant cover. In comparison to bogs, the water within fens is nutrient-rich. The fen is usually only a few centimetres higher than its associated water body and thus is seasonally flooded during high flows. These flood flows deposit sediments and have a significant effect on the vegetative composition of the fen. As with bogs, fens are concentrated in the northwest section of the corridor, but they are more widespread throughout the corridor. The most significant fen is associated with Burntland Brook, a tributary of the River Philip, located within Kilometre 3 of the corridor. The proposed alignment crosses this fen at right-angles, potentially affecting its hydrology and stability.

Successional changes within this habitat occur as flood frequency changes. This may occur as the stream changes in alignment or stream flows are affected. If flooding ceases, a forest habitat would become established. If the water level rises, succession will lead towards a sphagnum-dominated bog.

The vegetation of a fen is dominated by the bluejoint grass-sweet gale plant association (*Calamagrostis canadensis*, *Myrica pensylvanica*). Fens are valuable to a much broader range of wildlife than bogs. There is a rich fauna of insects, amphibians, birds and

small mammals. Birds common in fens include the Virginia rail, swallows, flycatchers, yellow warbler, and swamp sparrow. Small mammals include cinereous, water and Arctic shrews, star-nosed moles and muskrat. Many other animals use fens as part of their habitat requirements.

6.5.3.4 Field Surveys

A botanical survey of five wetlands in the northwestern section of the corridor was completed during October 4 to 6, 1991. Three of the wetlands were fens surrounding streams, one was a flat basin bog, and one was a large treed raised bog. These wetlands are identified on Figure 6 -14.

Two of the fens are associated with Burntland Brook and one with Tillits Creek, all tributaries of the River Philip. The fen associated with the main branch of Burntland Brook (Wetland A) averages 30 metres in width and is dominated by the grass (*Brachyelytrum erectum*) and common alder (*Alnus rugosa*); sedge clumps and sphagnum moss are found in wetter depressions. Other low ground cover includes white aster, goldenrod, meadow-rue, meadowsweet and dewberry. The overhead canopy comprises common alder, pin cherry, and scattered red maple. Wildlife signs in the vicinity indicated red squirrel, beaver, deer, moose, and coyote. Birds noted were downy woodpecker, ruby-crowned kinglet, white-winged crossbills, black-capped chickadees, and boreal chickadees.

The fen associated with the small tributary to Burntland Brook (Wetland B) is similar to the one on the main branch, but up to 50 metres wide in spots. Beavers are active upstream of the fen, cutting large poplars and building many dams. Only dark-eyed juncos were observed in this area.

The fen associated with Tillits Creek (Wetland C) is again similar to the other fens studied, except that the dominate grass is blue-joint. Several beaver dams are present in this area as well. Birds observed included blue jay, yellow-throat and

yellow-rumped warblers.

Flat basin bogs are the most common wetland throughout the lowland/wetland area shown in Figure 6-14. One series of such bogs was surveyed (Wetland D). These bogs are shallow with little or no open water. Grasses and sedges dominate the groundcover with common alder, willow and meadowsweet present in drier areas and bulrushes in wetter areas.

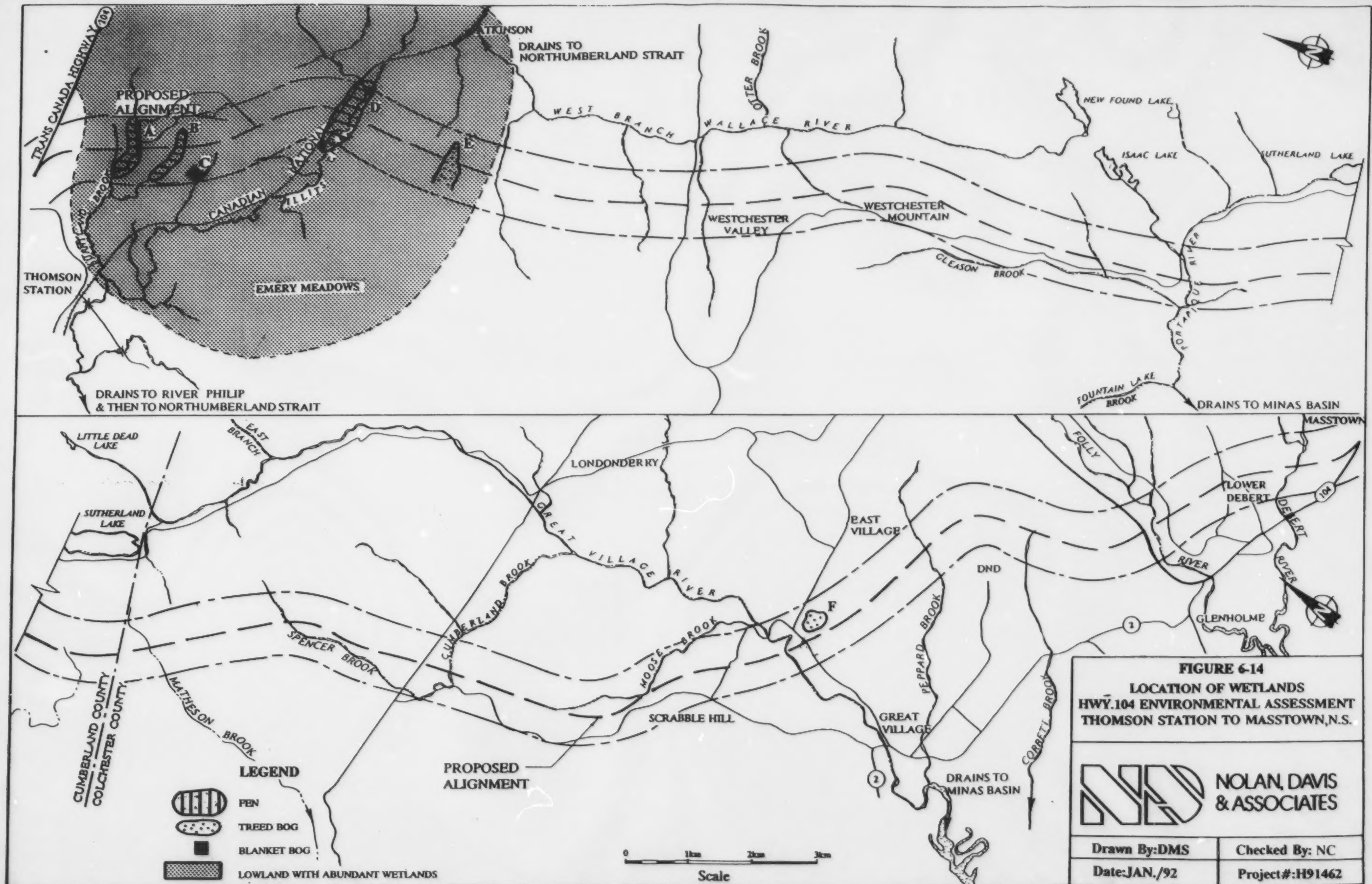
Wetland E, shown in Figure 6-13 is the largest bog crossed by the proposed alignment. This bog forms the headwaters of both Emery Brook, a tributary of the River Philip, and an unnamed tributary to the West Branch Wallace River. Ground vegetation is dominated by black spruce and larch overhead, with a sphagnum ground cover. The middle layer is a heavy growth of ericaceous shrubs such as rhodora, leather leaf, labrador tea, and sheep laurel. The occasional red pine throughout the bog suggests a very uneven topography beneath the surface, because red pine does not grow in wet sites. A peripheral moat (lagg) had a trace of open still water and the ground cover included bur-reed, pitcher plant, and small cranberry among the sedges and sphagnum. Probing with a 6.1 metre long rod indicated that the proposed centerline of the alignment passes through the deepest portion of the bog; while most of the bog has depths of a few metres to a hard surface, the bog is over 6 metres deep at the centerline.

This Emery Meadow bog appears to be a dish-like depression with outflows to both the east, to the West Branch Wallace River, and west to Emery Brook. While detailed flow studies were not conducted, the general configuration of the bog with the central pine-spruce covered rise (Figure 6-15) suggests that flow within the corridor is predominately towards the West Branch Wallace River.

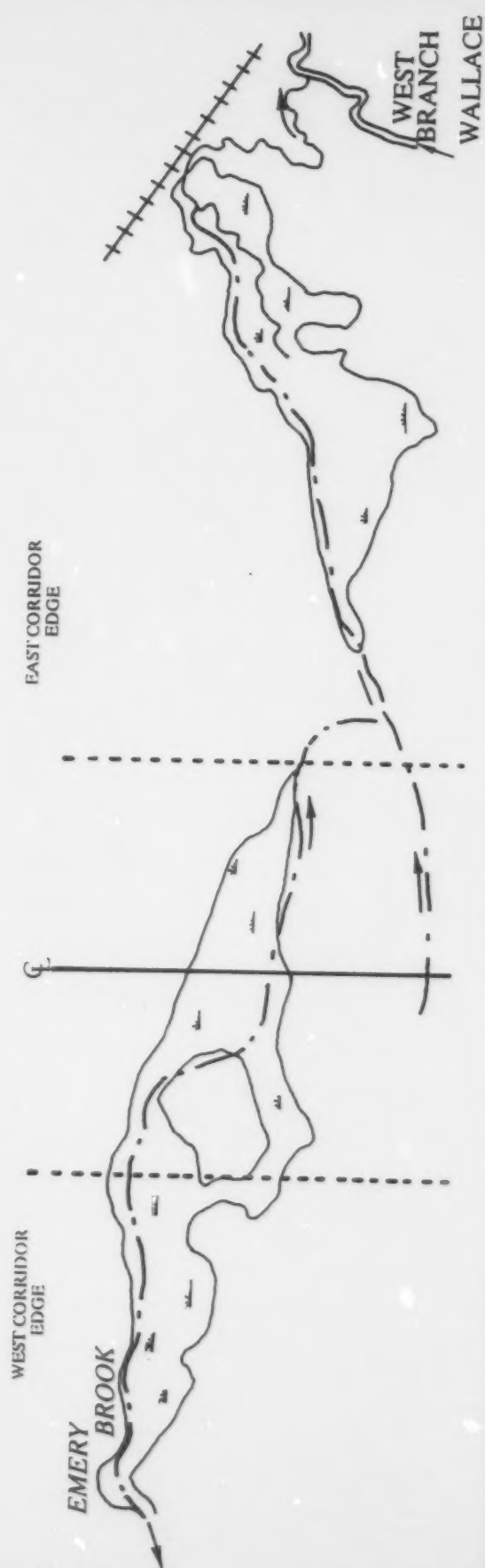
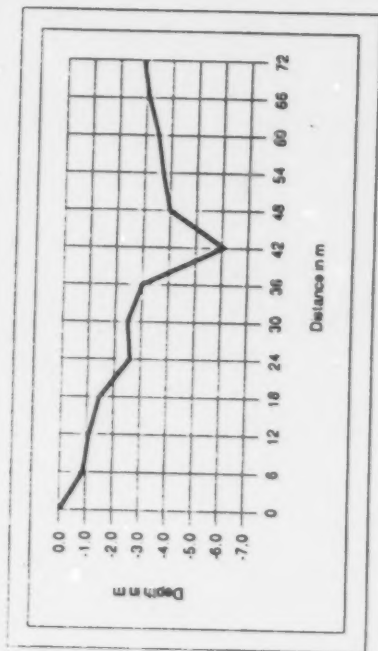
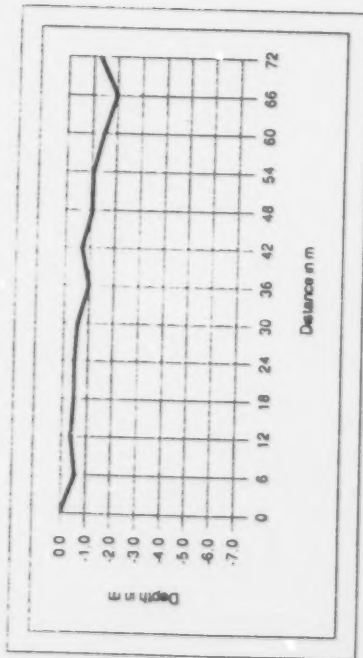
6.5.3.5 Rare Species and Habitat

Field surveys were conducted in early October when many rare plant species are not readily visible; however, ground cover associations were checked for each









NOLAN, DAVIS
& ASSOCIATES

FIGURE 6-15
EMERY MEADOW BOG
(WETLAND E)

JANUARY, 1992

HP1462

major land type and unusual habitat that would likely support rare plant species was not observed. In addition, no rare or endangered species of animals associated with these wetlands could be identified. While not rare or endangered, some species of amphibians and reptiles, like the four-toed salamander, have relatively specific habitat requirements associated with sphagnum areas (Gilhen, 1984) and are supported by these areas. Based on this assessment, it was judged that no further study was required to meet the Terms of Reference.

6.6 Historical and Cultural Resources

This section presents the results of a Phase II study of historical and cultural components identified as part of an environmental assessment of the proposed alignment. This type of study was judged essential given the number of historical and cultural components identified during the environmental screening (Phase I) which were in close proximity to the proposed highway.

6.6.1 Methodology

The approach used to evaluate the potential impact of the construction of the highway was multi-faceted. It recognized that the study area consists of highly diverse landscapes and therefore has the potential to contain heritage resource sites representative of all of the cultural traditions outlined in Table 6-15. The Phase I route screening study outlined two sets of preliminary data; documented sites and settlement pattern criteria for predicting the location of unknown sites. These databases were used to identify areas of high, moderate and low potential for cultural resources in close proximity to the proposed highway.

The Phase II study began with a review of the existing data compiled for the screening study. Contact was made with the Curator of Archaeology of the Nova Scotia Museum to ascertain the location of prehistoric sites within the corridor of the proposed highway. Although sites have been recorded in close proximity to the proposed highway none were known from within the corridor. The background study continued with an

extensive archival search, consisting mainly of an examination of maps dating from the eighteenth century to the present. The most useful of these resources were A. F. Church's maps of Cumberland (1873) and Colchester (1874) counties. These were augmented by Geological Maps of Nova Scotia, and an unpublished map of the road running from Great Village to Sutherland Lake.

TABLE 6-15

Cultural Chronology of Nova Scotia

Years Ago	Period	Tradition	Subsistence Focus
Present-300	Historic	English French Acadian Micmac	cities/towns/farming/manufacturing towns/farming/small manufacturing farming/small manufacturing reservations
300-	Proto-Historic	Micmac	hunting/gathering
500 - 2500	Ceramic	Maritime Woodland	hunting/gathering coastal, seasonal interior activities
2500- 5000	Late Pre-Ceramic	Broad Point Shield Archaic Maritime Archaic Laurentian Archaic	coastal, south interior, Boreal forest coastal, north Interior, river and lakes
5000- 8000	The Great Hiatus		Prehistory Unknown
8000- 11,000	Palaeo-Indian	Plano Clovis	big game hunters

With the background study completed, a team of two to three qualified archaeologists conducted a pedestrian survey of the study area. They initially located all of the high and moderate potential zones identified in the Interim Report. These areas were

traversed on foot and were shovel tested where deemed necessary. The testing involved spaced, subsurface excavations in areas which fit the settlement pattern criteria outlined in the Interim Report. All level terraces that afforded the potential of prehistoric settlement along major rivers and brooks were examined and tested. A total of 50 person days were used in the actual field study with an estimated 80 percent of the actual route being covered on foot.

Throughout the archaeological survey contact was made with various residents within the study area. They were asked if they had knowledge of cultural resources or knew of individuals who could assist in locating such resources in the study area. With the cooperation of the owners, Layton's General Store in Great Village became an informal information center for the survey team. Their assistance in the study is greatly acknowledged.

Through this methodology, historical and cultural resource sites were located and, tested (where necessary) within the proposed highway corridor. Each of the resources was recorded on a separate Maritime Archaeological Resource Inventory (MARI) form. Under the Terms and Conditions of the Special Places Protection Act, copies of the MARI forms along with fieldnotes and a report will be deposited with the Nova Scotia Museum separately from this document.

6.6.2 Study Area Review

For the convenience of this report, the proposed highway was divided into six sub-regions based on logical geographic divisions. The six sub-regions, from north to south are:

1. Thomson Station to Westchester Valley
2. Westchester Valley to Portapique River
3. Portapique River to Lornevale
4. Lornevale to Great Village River
5. Great Village River to Folly River

6. Folly River to Masstown overpass

Sub-region 1 begins at the present Highway 104 between Birchwood and Thomson Station, south through Emery Meadows to the Rose - Westchester Station road.

In the north of the sub-region the ground rises to the north of Burntland Brook and is characterized by a mixed forest. The ground between the high ridges is swampy but no significant water sources are present. No potential was seen for this area.

The land begins to rise slightly to the north of the railway tracks west of Atkinson. It becomes very low with isolated swamps in the area of Burntland Brook and its several small tributaries. The forest is composed almost solely of spruce. The main brook is 1.5 to 2 metres wide, moderately fast-flowing and surrounded by alders.

Travelling north the land becomes low and swampy in the area of Emery Meadows. The highest land in the area is a large plateau-like hill to the west of Atkinson, just south of Tillits Creek. This creek is fast-flowing but only a metre wide and is surrounded by alders. The high ground slopes moderately down to the creek. The slope was examined on foot and the plateau both on foot and by shovel testing. These shovel tests proved negative. A wide dirt road travels from Atkinson west over the plateau southwest past Emery Meadows. The ditches on both sides of this road were checked with negative results.

The southern end of the area is moderately hilly with a hardwood forest. The West Branch Wallace River passes to the east of the area and it was followed to its largest tributary west into the area. The stream is only one to two metres wide and moderately fast. Some slight ridging is present but no areas of high or moderate potential were observed.

Sub-region 2 begins at the Rose-Westchester Station Road south along Westchester Mountain to the Portapique River. This area contains extensive blueberry fields. It is also the location of an early pioneer settlement which has left extensive cultural remains. The most significant being a cemetery (1991 NS 22-3) which covers two small knolls on the east side of the dirt road. The earliest headstone is dated 1789 with the latest being 1925. It should be noted that not all of the graves are marked. The site is characterized by a number of depressions in line with marked graves that represent burials, it is estimated that at least 63 individuals are interred in this cemetery.

The survey of this sub-region was greatly assisted by Mr. Garnet Rushton of Collingwood. Mr. Rushton's family had been long-term residents of the area, abandoning the family farm in the 1960's. He was able to pin point the location of the church associated with the cemetery. It was to the west and adjacent to the southern knoll (oldest section) of the cemetery. What may have been a very crude foundation of large stones was observed, however, shovel testing proved negative. Mr. Rushton also reported an extension of the cemetery in a hollow to the east of the present marked graves. A ground search of the area failed to produce surface indications of a cemetery.

As a result of the public meeting a second informant, Mr. George Johnston also of Westchester Valley, contacted the survey team. He presently lives on the site of Purdy's Inn which dates from the 1860's. His initial concern was the impact the proposed highway would have on this property, however, it was determined that it lies outside of the corridor. He introduced the team to a Mr. Raymond Halliday who was also a life-time resident of the area. Mr. Halliday had found a Ceramic Period projectile point in his pasture near Rose. The location of the find is outside of the study area.

Information from the informants combined with Church's map of Cumberland County and the survey resulted in the following cultural resources being recorded in this sub-region:

1991 NS 22-1 This feature is 1.5 kilometres south of the Rushton Pioneer Cemetery, 325 metres northwest of the gravel pit, 25 metres west of the road down a gravel drive. It is now an open area with no evidence of a foundation. The area is littered with building debris and at least one appliance indicating that it was occupied until quite recently. No reason was seen to test the site.

1991 NS 22-2 This feature is 2.5 kilometres south of the Rushton Pioneer Cemetery, about 15 metres east of the road. It is a large dry stone foundation at least half of which is now occupied by a hunting camp. This site was not tested.

1991 NS 22-3 This site consists of the Rushton Pioneer Cemetery and the possible remains of a Church. It was first mentioned by Garnet Rushton as the site of an early 19th century church associated with the cemetery, and he delineated the area with flagging tape. A crude, apparently single course of stones, roughly ten by five metres, does suggest a foundation. Shovel tests on the exterior, however, proved negative.

1991 NS 22-4 This site is 75 metres west of the Rushton Pioneer Cemetery, 25 metres west of the road. It is a small (4.40 x 3.20 metres) dry stone foundation consisting of a single course. Shovel tests revealed late 19th century ceramics, including ironstone. It would most likely date after the making of the Church map (i.e. post 1873).

1991 NS 22-5 This feature is located 150 metres west of the Rushton Pioneer Cemetery, 25 metres west of 1991 NS.22-4. It is a large (17.5 x 8.8 metres) dry stone foundation with three interior walls or supports. The north wall has been partially destroyed by the building of an E-W running road. This site was not tested and was assumed to be an outbuilding for 1991 NS 22-4

1991 NS 22-6 This feature is 500 metres north of the Rushton Pioneer Cemetery, 100 metres east of the road. A N-S running dirt road travels past its east side. It is on a high, level piece of ground. Any foundation that may have been present has either been removed or is buried by recent heavy machinery activity. Evidence of its past function is abundant on the surface in the form of late 19th and early 20th century glass and ceramics. Shovel testing revealed late 19th century ceramics including ironstone and Maritime ware.

1991 NS 22-7 This foundation is indicated on Church's map as belonging to E. Rushton, who, according to Garnet Rushton, was Elijah (d.1867). The area had previously been settled by Elijah's father Peter. The house was apparently abandoned in the 1960's. Shovel testing did not reveal anything earlier than the late 19th and early 20th century.

1991 NS 22-8 This site is on the road to 1991 NS 22-7, 50 metres to the south of it. It is a small (4 x 4 metres) deep, dry stone foundation surrounded by alders. There are early to mid-20th century artifacts on the surface around the foundation and shovel tests revealed artifacts of the same date.

1991 NS 22-9 This feature is 40 metres southwest of 1991 NS 22-8 and is a dry stone foundation (about 10 x 10 metres) which has been filled and used as a parking area. The slope on its west side has 20th century glass on the surface.

1991 NS 22-10, 11, 12 These sites are visible now as three filled-in features on the mid-slope of a cleared field, 2.25 kilometres north of the Rushton Pioneer Cemetery, about 50 metres west of the road. These should not be threatened by the highway construction and, therefore, were not tested.

1991 NS 22-13 This is an overgrown cellar (about 7 x 7 metres) 2.55 kilometres north of the Rushton Pioneer Cemetery, 20 metres west of the road. It appears to have been abandoned in the last 30 or 40 years and the artifacts on the surface seem to confirm that fact. This site was not tested.

1991 NS 22-14 This site was shown to the survey team by George Johnston. It is 3.15 kilometres north of the Rushton Pioneer Cemetery, 25 metres west of the road. It has been filled-in but appears to have been about 6 x 6 metres. It is on the edge of a blueberry field and has been subject to a lot of machinery activity. Shovel testing revealed late 19th and early 20th century ceramics.

1991 NS 22-15 This is a large foundation (about 10 x 8 metres) and is 3.5 kilometres north of the Rushton Pioneer Cemetery on the east side of the road. It is a dry stone foundation overgrown by alders but appears to have been occupied up to the relatively recent past. Shovel tests revealed mid-20th century artifacts.

1991 NS 22-16 This house is shown on Church's map and is located 4.25 kilometres directly north of the Rushton Pioneer Cemetery, on the north side of the dirt road running east off the main road. It is a large dry stone and brick foundation (14.6 x 8.9 metres) in an open field. An associated out-building is 30 metres to the east. The presence of machine-cut nails and the few ceramics from shovel tests suggest a last half of the 19th to early 20th century occupation.

1991 NS 22-17 This house is also shown on Church's map and is located 4.20 kilometres directly north of the Rushton Pioneer Cemetery, on the south side of the road running east off the main road. It is a dry stone and brick foundation (12.8 x 6.5 metres) with a partial cellar. An associated outbuilding is 25 metres to the southwest. Shovel tests revealed only 20th century artifacts.

Sub-region 3 extends from Portapique River to an area about 1.5 kilometres west of Sutherland Lake ending at the intersection of the proposed highway with the Lornevale - Londonderry Road, 1.25 kilometres west of the Old Cumberland Road to Sutherland Lake.

The dominant cultural activity within this sub-region is related to the iron workings in and around Londonderry. The Archibald maps of 1859 identified an iron mill on Spencer Brook placing it on the west edge of the proposed highway corridor. The mill complex was located about 750 metres north on the Old Cumberland Road, just below a small set of waterfalls, on the east bank of Spencers Brook. The complex (1991 NS 22-19) comprises two water-filled pit features, a man-made flume which runs southeast and parallel to the river and the remains of a bridge above the waterfalls. Testing revealed a greasy gray/black soil containing crushed rock which would confirm its function as an iron mill.

The Interim Report placed a reported prehistoric site on Spencer Brook in this general area. An extensive survey along both banks and the terraces above the Brook failed to produce any evidence of this site. Informant interviews with local residents also failed to produce any knowledge of the site. Subsequent review of the Museum records located the original informant. The actual location of the find was on the Portapique River well outside of the proposed highway corridor.

The survey continued north towards Sutherland Lake, following the proposed route on the east side of Spencer Brook. This area is characterized by mixed forests with steep slopes down to the brook. The survey team noted numerous pits and piles of broken rocks resulting from early mining activities. These are referred to in general on the 1905 Geological Survey of Canada map. Other than these no other cultural remains were encountered.

Sub-region 4 runs from the Lornevale - Londonderry Road south to the Great Village - East Village Road.

The proposed new highway will travel south across Moose Brook through a small valley to bisect the Lornevale - Londonderry Road. The valley has a gentle slope with rocky ground and a young hardwood forest. The area of Matheson and Cumberland Brooks is very low and swampy with alders. No cultural features were encountered in the area.

The edges of the field to the south of Spencer Cross Road were checked, but examination of the rest of the field was impeded by the presence of a large number of cows and a young bull. No cultural features were encountered on the edges of the field.

The fields to the north and south of Spencer Cross Road were checked. A building is shown by Church to be about 150 metres east up the road from Scrabble Hill on the north side of the road. A small rectangular depression is visible in this area (1991 NS 22-20). Testing revealed a small amount of refined white earthenware.

The survey team travelled up Moose Brook from its confluence with the Great Village River northwest through to the study corridor. The banks of the brook are bounded by high, steeply sloping ground with an old logging road running beside the river. No cultural features were encountered.

A twentieth century "dump" was encountered just southwest of where Spencer Cross Road crosses Moose Brook, but no other evidence such as a foundation(s) was found associated with it.

Church's map shows several buildings in the south end of the area but they fall just outside the study corridor. The Great Village River runs through the south end of the area. The river north of the bridge is six to eight metres wide with cobblestone banks. A floodplain to the northeast of the bridge was checked with negative results. The north and south banks of the river were checked as well as a field to the south of the bridge. To the west of the bridge is a high sandstone ridge which follows the river south of the bridge.

The length of this ridge was checked. The south end of the ridge slopes down to the river. A gravel pit in this area was checked and as well, several test holes were dug along the river's banks and two large test holes on the south slope of the ridge, all with negative results.

Sub-region 5 was defined as the area between the Great Village - East Village Road south to the point where the proposed highway crosses the present Highway 104. It is characterized by low wetlands covered in mixed forest. The only water sources are the beginning of Corbett Brook and Peppard Brook, neither are judged to be significant for attracting cultural developments. The survey team investigated the area including a large ploughed field east of the Department of National Defense (DND) station with negative results.

Sub-region 6 begins at the point where the Highway 104 is crossed by the proposed highway and ends where the Masstown Road crosses over the present Highway 104.

The area where the highway will cross the Debert River was thoroughly examined. It is characterized by low wet ground which offers little in the way of human occupation. The area of the Folly River initially appeared to have high to moderate potential. However, the inspection by the survey team along ploughed fields failed to produce any evidence for cultural resources. Sub-surface testing on the ridges above the river also produced negative results. The only cultural feature noted was a dirt track on the west side of the river. This old road was investigated and no cultural features were noted within the corridor. The southern end has very little potential, it is a low area of mostly spruce with some slight ridging, with no major bodies of water.

6.7 Existing Social Environment

Because the corridor along the proposed highway alignment is largely uninhabited, there is relatively little social environment to be affected by the project. The proposed highway alignment (encompassing a study corridor of approximately 1,000 metres)

includes clusters of up to ten residential dwellings in only four locations: at Thomson Station, Scrabble Hill, East of Great Village and North of Glenholme. The only sizeable population centers within the vicinity of the new sections of the proposed highway corridor are located at the southern end, including Debert and Glenholme.

6.7.1 Land Use

Land use within the proposed corridor area is not restricted by law in either Cumberland or Colchester Counties. As indicated in Table 6-16 the dominant exploitative land-use in terms of area is clear cut logging, followed by blueberry cultivation and other active agricultural production. Residential areas, with the exception of farms and other isolated dwellings, are not a major factor within the corridor.

TABLE 6-16

Area of Managed Land-use within the Corridor

Land-Use	Area (hectares)
clearout logging	880
blueberry fields	241
active agriculture	206
replanted forestry	67
residential/urban	36
other developments	28

The southern portion of the corridor between kilometres 33 and 46 contains substantial areas of potentially good agricultural land.

6.7.1.1 Blueberry Cultivation

The cultivation of lowbush blueberries is a dominant land-use feature along the proposed alignment. The biophysical environment of the Cobequid Highlands is one of the best in Nova Scotia for commercial production of lowbush blueberries. Cultivation

entails encouraging the natural recolonization by blueberry plants of an area that has been either abandoned as agricultural land or cleared specifically for blueberry production. As a result, the marketable productivity of a field increases with time as the plant mass becomes more dense over consecutive years of husbandry. According to the Nova Scotia Department of Agriculture and Marketing blueberry specialists, the Highland fields through which the proposed alignment passes are some of the oldest in the province. This fact, combined with the environmental conditions noted earlier, make these fields among the most productive per hectare in Nova Scotia. (Jack Sibley, pers. com.) General areas of production within the corridor are identified in Figure 6-17.

6.7.1.2 Active Agriculture

Agricultural activity along the alignment coincides closely with the crossing or paralleling of the existing road infrastructure. Cultivation for livestock production comprises the major agricultural land-use (excluding blueberries) within the corridor area. Small areas of cash crop or horticultural crops are situated within the study area. However, substantial acreage of high value horticultural land in the Great Village - Glenholme area is irrigated with water drained watersheds crossed by the alignment.

There are three concentrated areas of agricultural activity within the corridor as shown on Figure 6-17.

6.7.1.3 Land of Agricultural Potential

The Canada Land Inventory (CLI) has divided mineral soils into seven classes according to increased limitation of agricultural use. Classes 1, 2 and 3 are considered capable of sustained production of common field crops, whereas Class 4 is considered marginal for this use.

Soils in Class I have no significant limitations for crop production. However, because the regional climate is considered a limitation for optional crop growth, no land units in Nova Scotia nor in the Maritime provinces are rated Class 1. Therefore,

in the Maritime region in general and in Colchester and Cumberland counties in particular, soils which would otherwise be rated Class 1 have been designated Class 2.

In Cumberland County, 12 percent of all lands are rated Class 2 while 25 percent are rated Class 3. Figures for Colchester County indicate that nine percent are rated Class 2 whereas 27 percent are Class 3. Table 6-17 describes the number of hectares of potential and presently cultivated Class 2 and 3 land within the proposed alignment corridor.

A 90 metre right-of-way will include approximately 54 hectares, or 0.2 percent, of the total cultivated and potential Class 2 land and 13 hectares, or 0.01 percent, of the Class 3 land in Colchester County, and 45 hectares, or 0.04 percent, of the Class 3 land in Cumberland County, from agricultural production.

TABLE 6-17

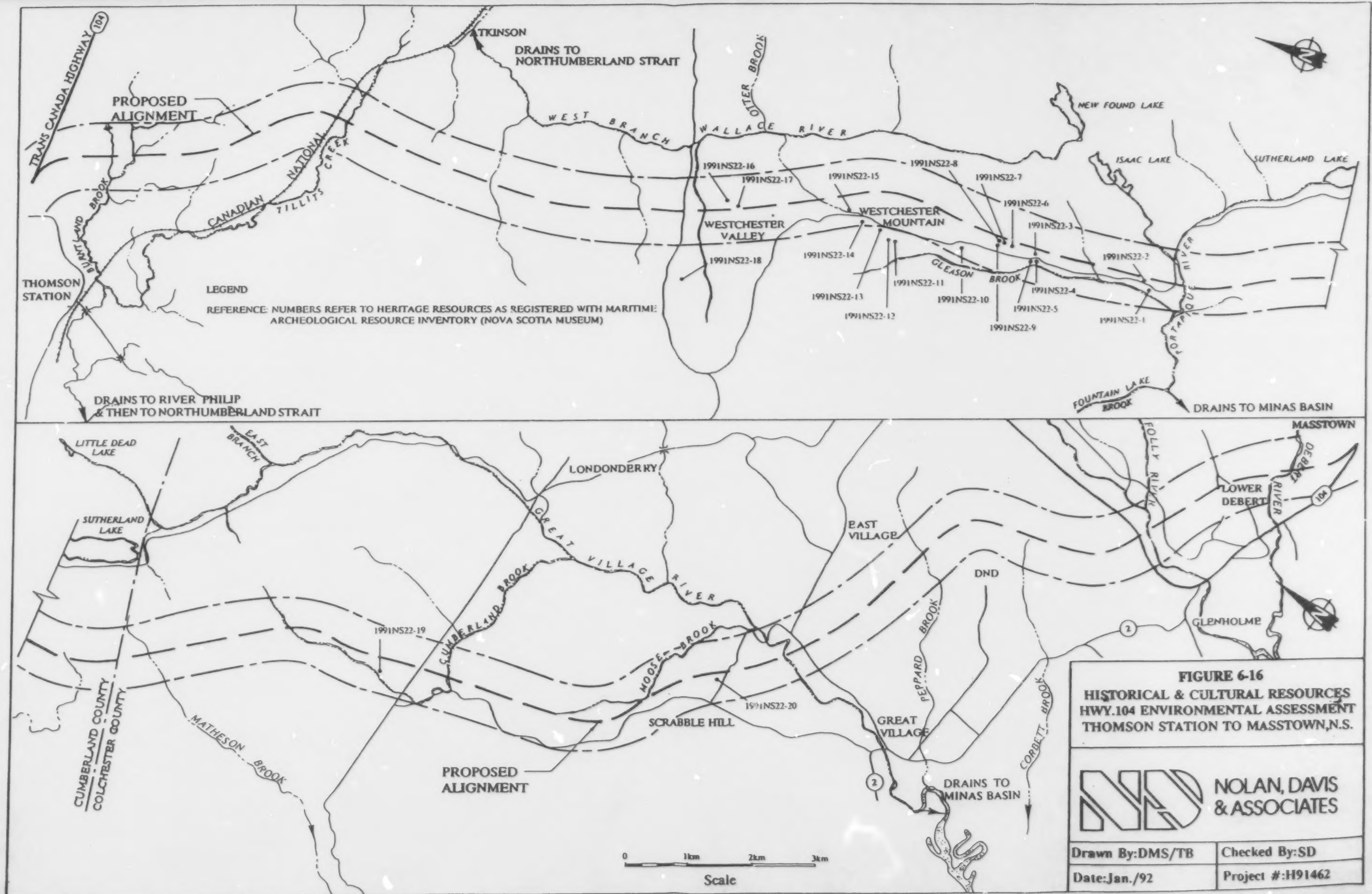
**Soils of Agricultural Potential within Corridor
(hectares)**

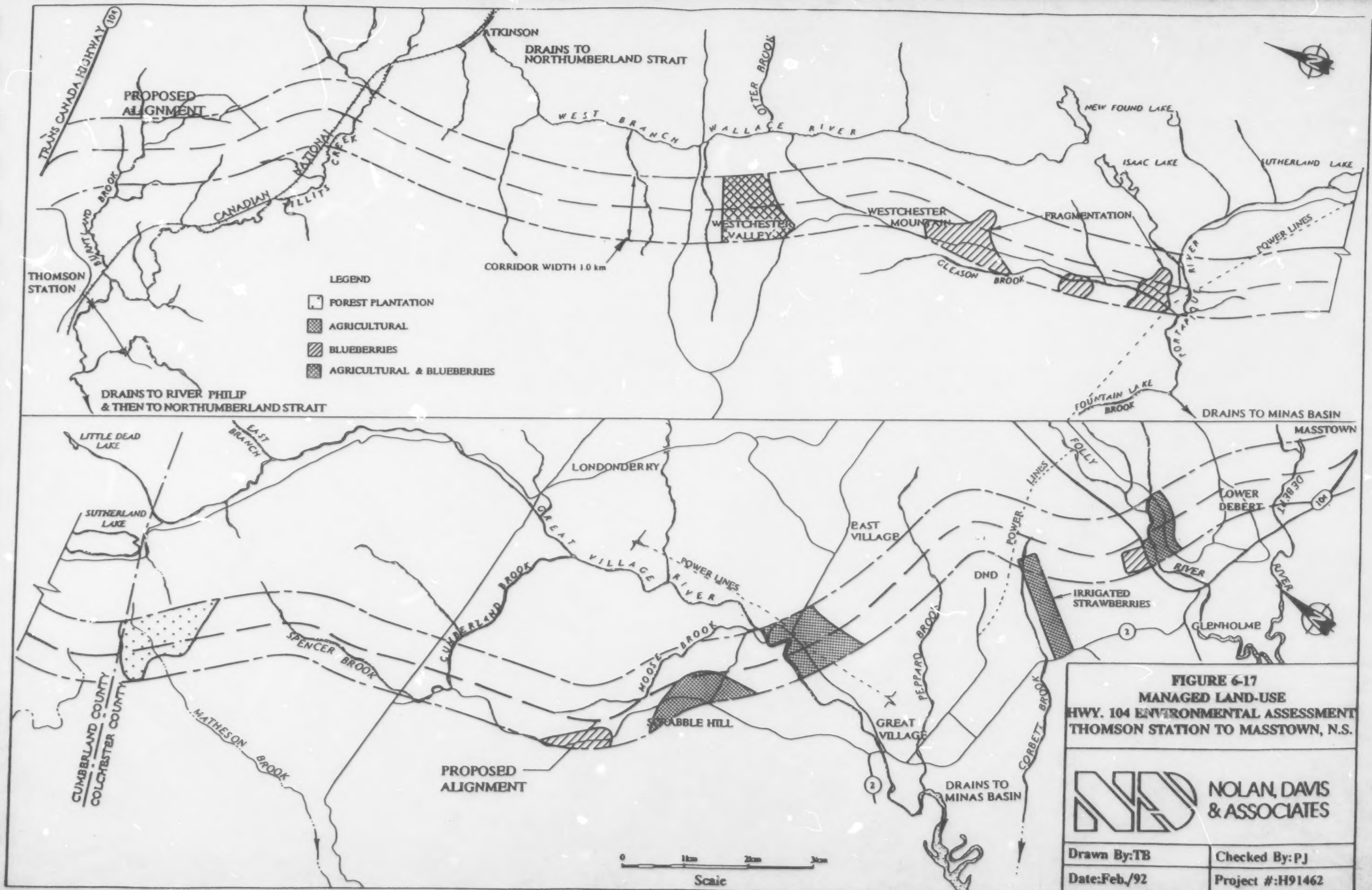
<u>Presently Uncultivated</u>		<u>Cultivated</u>	
<u>Class 2</u>	<u>Class 3</u>	<u>Class 2</u>	<u>Class 3</u>
600	650	100	0

6.7.1.4 Recreational Land Use

Established recreational land uses identified close to the proposed alignment include the Elm River Park (trailer/campground), cottage development at Sutherland Lake and snowmobile trails in the vicinity of the lake. There are no Federal or Provincial Parks or Reserved Indian Lands within or near the proposed alignment corridor.









The variety of wildlife and birds in the study area form an important recreational resource, attracting birdwatchers, photographers, hikers and outdoor enthusiasts to the region. It is however, difficult to assess the extent of these unmanaged land-uses.

6.8 Access Road Conditions

The following nine roads are intersected by the proposed new Highway 104 from Thomson Station to Masstown:

Road Name	Surface Type
Jersey Road	Gravel
Wentworth-Collingwood Road	Paved
Westchester Road	Gravel
Mines Bass River Road	Gravel
Station Road	Paved
Gray Road	Gravel
Middle Road	Paved
Bulmer Cross Road	Paved
Highway 104 (Existing)	Paved

Full interchanges will be provided to the existing Highway 104 at Thomson Station, Glenholme and Masstown. There is a possibility that a full interchange will be designed and constructed at the Wentworth-Collingwood Road. All other minor roads will

be grade-separated from the new Highway 104, and thus no increase of traffic is anticipated on these minor roads due to construction of the new Highway 104. Recent traffic counts for these roads are provided in Table 6-18.

TABLE 6-18

Recent Traffic Counts

Location	AADT	Date of Count
Highway 104:		
1 km east of Rt. 321 (Oxford)	7,310	June 30 -July 7/92
2.5 km east of Rt. 368 (Mahoneys Corner)	7,260	23-30 June '92
0.5 km east of Rt. 307 (Wentworth Center)	7,260	16-22 June '92
3 km east of Rt. 246 (Wentworth)	8,010	16-23 June '92
2.5 km east of Trunk 2 (Masstown)	10,000	16-23 June '92
1.5 km east of Trunk 2 (Glenholme)	10,500	16-22 June '92
Folly Mountain	6,530	1991 - Permanent Counter
Other:		
Middle Road (1km north of Bulmer Cross Road)	280	8-15 Sept.'92
Bulmer Road (1 km north of Hwy. 104)	240	8-15 Sept.'92
Westchester Road (4.8 km north of Col./Cumb. Line)	70	8-15 Sept.'92
Mines-Bass River Road (0.8 km east of Lornevale Road)	120	8-15 Sept.'92
Station Road (2.7 km east of Trunk 2)	450	8-15 Sept.'92
Gray Road (2 km north of Middle Road)	60	8-15 Sept.'92
Collingwood-Wentworth Rd. (3.2 km east of Westchester Road)	140	8-15 Sept.'92

AADT Average Annual Daily Traffic

Figures were extrapolated from traffic counts in summer 1992

6.9 Valued Environmental Components (VEC's)

Based on the review of the existing environment in the study area, the following environmental components would be classified as VEC's:

- Air Quality including noise
- Surface Water
- Groundwater
- Fish
- Climax Hardwood Stands
- Wildlife
- Wetlands
- Land Use including blueberry barrens
- Cultural Heritage Resources
- Social/lifestyle Values

These components will be considered in the following section in which impacts of the project on the environment are reviewed.

6.10 Existing Regulatory Climate

All environmental laws and regulations existing in the province are applicable to NSDOTC and to the design, construction and operation of this proposed section of highway. The following list identifies the specific acts which may be applicable:

Federal Legislation

1. Canadian Environmental Protection Act & Regulations
2. Transport of Dangerous Goods Act & Regulations
3. Fisheries Act
4. Oil and Gas Product and Conservation Act & Regulations

5. Pest Control Products Act and Regulations

Provincial Legislation

1. Environmental Assessment Act & Regulations
2. Environmental Protection Act & Regulations
3. Water Act & Regulations
4. Dangerous Goods Transportation Act & Regulations
5. Dangerous Goods and Hazardous Waste Management Act & Regulations
6. Pest Control Products (NS) Act & Regulations
7. Provincial Parks Act
8. Litter Abatement Act & Regulations
9. Weed Control Act

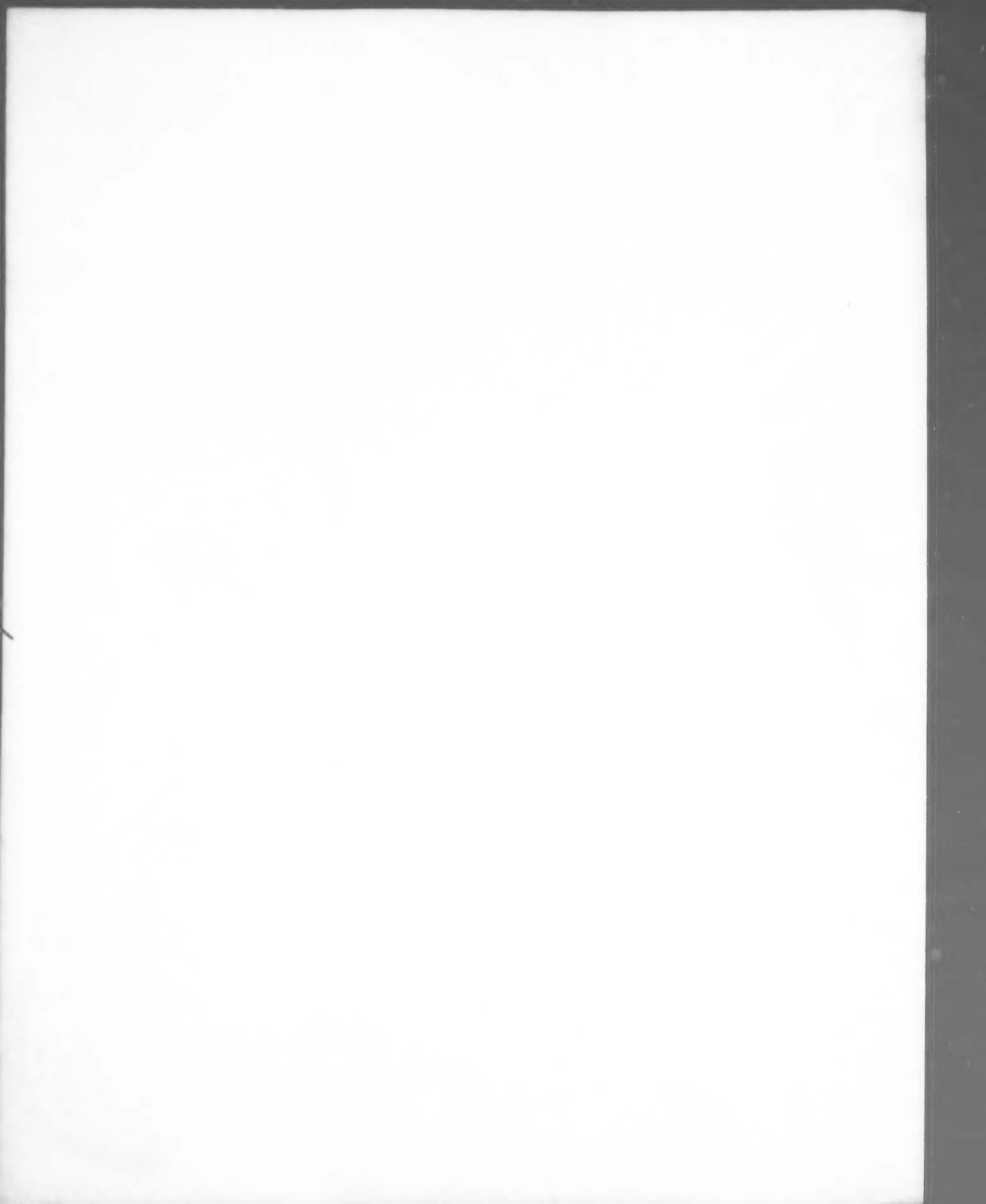
In addition to the various acts listed above, the following guidelines issued by the Nova Scotia Department of Environment may apply to the project:

1. Environmental Construction Practices Specifications
2. Erosion and Sedimentation Control Handbook for Construction Sites
3. Policy Guidelines for Watercourse Alterations
4. Contingency Plan for Releases of Dangerous Goods and Hazardous Wastes
5. Pit and Quarry Guidelines
6. Guidelines for development of slates in Nova Scotia

Municipal Legislation

In addition to the above, certain municipal or county requirements will have to be addressed in relation to waste disposal sites, topsoil removal, building permits, access rights and blasting.

PART 7
ENVIRONMENTAL IMPACTS



7.0 ENVIRONMENTAL IMPACTS

This section of the report provides an interaction between the description of the project in Part 2 and the description of existing environment in Part 6. It assumes that normally accepted environmental management practices will apply. Specifically required mitigative measures are described subsequently in Part 8 of the report.

Part 7 is organized to describe impacts first on the atmospheric environment, followed by the aquatic and terrestrial environments, and concluding with social impacts. A summary/overview of impacts is provided at the end of the section.

7.1 Impacts to the Atmospheric Environment

7.1.1 Air Quality

Air quality impacts will result from the following aspects of this project:

- Construction equipment
- Burning of waste during construction
- Miscellaneous construction activities
- Highway operation

Table 7-1 outlines the types of emissions and the components of those emissions from each type of source.

7.1.1.1 Impact of Construction Equipment

Emissions related to the construction equipment are those typical of vehicle operation where gasoline or diesel fuel consumption takes place. Significant amounts of exhaust and working fluid components are emitted into the work area. Primary components of emissions include carbon monoxide, nitrogen oxides, hydrocarbons and ash. While creating occasional nuisance problems on the construction site, these materials generally do not present significant problems at adjacent sites because of their transitory nature.

The impact of earth-moving equipment operation is relatively uniformly distributed over the length of the project except where large volume earth-moving

requirements will require the residence time (in days) to be significantly greater. Impacts will also be greater along primary access routes for the construction. Where the impact of these operations will result in temporary concentrated or longer duration exposure to emissions, operational changes can sometimes reduce or mitigate impacts to acceptable levels.

The impact of these mobile sources is discussed further in Section 7.1.1.4.

7.1.1.2 Burning of Waste

Methods for the disposal of combustible waste such as clearing debris may include burning. Where burning takes place, significant amounts of particulates are released as well as various amounts of gases and trace toxic compounds generated due to the low fire temperatures achieved during open burning. The updraft created by the fire readily suspends fine particles causing wide dispersal. Depending on meteorological conditions and the methods employed, waste burning can result in impacts on adjacent sites.

Burning of clearing debris would tend to take place more in undeveloped areas and will therefore be less of a concern in cleared and populated areas. Judicious planning can reduce impacts to acceptable levels if specific care is used in populated areas or adjacent to other sensitive areas. Forest fire prevention requirements may also impact on these operations unless they are carried out in the off-season. Procedures which can be implemented in sensitive locations and other mitigative procedures are described in Section 8.2.3.

TABLE 7-1

Sources and Descriptions of Air Quality Emissions

	Operation	Emissions	Components
1.	Construction Equipment	Diesel engine exhaust Gasoline engine exhaust Lubricants Hydrocarbon vapours Odour	Suspended particulates Sulphur dioxide Nitrogen oxides Carbon monoxide fuel vapour PAH's carbon dioxide liquid hydrocarbon hydrogen aldehydes water nitrogen
2.	Burning	Particulates Smoke Odour	Suspended particulates Sulphur dioxide Nitrogen oxides Carbon monoxide PAH's methane carbon dioxide hydrogen aldehydes water nitrogen
3.	Miscellaneous Activities	Particulates Solvents Fumes	Suspended particulates Hydrocarbon solvents trace elements
4.	Highway Operations	Diesel engine exhaust Gasoline engine exhaust Lubricants Hydrocarbon vapours Odour	Suspended particulates Sulphur dioxide Nitrogen oxides Carbon monoxide fuel vapour PAH's carbon dioxide hydrogen aldehydes water nitrogen

7.1.1.3 Miscellaneous Construction Activities

In addition to the operation of construction equipment, the actual construction operations and materials used will result in airborne emissions. These will primarily be dust particulates which become airborne during earth-moving, drilling and blasting operations. Minor impacts may also include solvent release from coatings used on structures and the roadway as well as fumes emitted during welding or other special processes. These impacts will be uniformly distributed over the length of the project except for material handling, processing, bridge or storage sites.

Particulates can become airborne as a result of the following operations:

Clearing	Fill placement
Drilling	Roadbed preparation
Grubbing/Topsoil removal	Material processing
Soil borrow	Bridge construction
Blasting	Material spillage,
Small vehicle operation	piling and storage
Heavy-duty vehicle operation	Site completion

Uncontrolled emission of particulates may result in problems on the construction site itself and, under special circumstances, offsite. In extreme cases, health effects such as decreased lung function or other reactions can take place in sensitive individuals. Extremely high and continuous levels are needed for adverse effects to be seen on vegetation or agricultural crops. More usual effects include those of reduced visibility, soiling, and general nuisance.

As indicated in Section 6.3.3.1, a study of particulate emissions in Nova Scotia for 1980 found that 35.5 percent of particulate emissions came from construction sites, while 55 percent came from unpaved roads. Mining/quarry operations, slash burning and sand and gravel processing were attributed 0.5, 0.8 and 0.07 percent respectively. In operations where clearing, grubbing, extraction and handling of mineral materials are involved, an estimated 40 percent of particulate generation originates with the use and maintenance of access roads

while 34 percent originated during stripping/grubbing operations. A further 10 percent arose from dumping of hauled matter.

The generation of particulates which come from unpaved roads depends on the silt content of the soils being used, the proportion of dry days, driver habits, vehicle numbers and speeds, vehicle weight and the number of wheels on the vehicles.

National Cooperative Highway Research Program (NCHRP) studies found that dust from construction activities settles out very quickly and that a level of 150 micrograms per cubic metre will be exceeded at a distance of 50 metres, only two to three percent of the time. Stated differently, the information collected showed that, to exceed an annual geometric mean concentration of particulates of 72 microns per cubic metre at a distance of 20 metres from the road, the construction time at a given site would have to be two months.

Problems with particulates are highly unlikely with this project, particularly because of its essentially rural location, however, some specific mitigation recommendations are provided in Section 8.2.1 for implementation in unusual circumstances.

NCHRP studies indicate that hydrocarbon emissions from construction, particularly since the advent of the use of emulsion carried paving primers, are minor. Hydrocarbon vapours from asphalt paving are quickly dispersed and are relatively nontoxic.

7.1.1.4 Highway Operations

Air pollution emissions from the highway after completion of construction relate primarily to the operation of motor vehicles, but will also involve the resuspension of particulates on the roadway surface.

In locations where traffic volumes are high, where winds are limited or surrounding topography or structures limit air movement, significant build-up of pollutants

may take place. These conditions will exist along the proposed alignment in only rare and unusual circumstances for the foreseeable future.

Momentary levels of carbon monoxide and nitrogen oxides of 20 ppm and 200 ppb respectively were predicted for a 100 series Highway construction site by P. Lane in a EA study for Highway 107 Extension in Halifax County, Nova Scotia. Suspended particulate levels between 33 and 96 micrograms per cubic metre were determined during monitoring adjacent to a rural, commercial site during dry, dusty weather, by Jacques, Whitford during an EA study for Highway 104 from Alma to Salt Springs.

A study by Wanner et. al. 1989 on pollution levels on Swiss streets found that while levels of carbon monoxide and nitrogen oxides, immediately adjacent to streets, attained levels of over 12 ppm and 300 ppb respectively, levels at a distance of 40 metres dropped dramatically and were similar to background levels at a distance of 80 metres. Levels at 40 metres were usually only 20 to 50 percent of levels immediately adjacent to the traffic and below or close to regulatory limits. Nitrogen dioxide levels dropped somewhat more slowly as conversion of nitrous oxide to nitrogen dioxide was taking place in the near zone. Pollutant levels decreased the most in suburban and open areas with increased distance from the traffic lanes.

Average annual wind speeds in the study area are estimated at about 15 kilometres/hour. Average wind speeds during July through September are estimated at 12.5 kilometres/hour. Calm conditions will exist in the study area from five to six percent of the time during the summer months. The most severe air pollution conditions could potentially exist during calm conditions which occur during the summer months when background pollutant levels are higher because of transport from highly urbanized areas to the southwest.

P. Lane, in the Highway 107 Study, concluded that "Impacts on air quality during the operation of the Highway 107 Extension are not considered to be significant."

In the unlikely event that conditions combine to present localized difficulties during construction, some mitigation measures for short term conditions are presented in Part 8. Under normal conditions, local air movement will be ample to prevent significant build up of pollutants adjacent to the highway. It is not anticipated that Highway 104 will be located in close proximity (less than 100 metres) to any residences where air flow is restricted. This circumstance would be the only situation in which mitigative measures would be recommended for the actual operation of the highway.

7.1.1.5 Positive Impacts

In overall terms, the new highway could have a long-term beneficial effect on the air quality of the region. The availability of four lanes in a divided configuration will allow traffic to cruise at a near constant speed with a resultant reduction in emissions of all types, but particularly in emissions of carbon monoxide and hydrocarbons. Studies have shown that decreasing acceleration and deceleration, and the ability to maintain a constant speed reduces these emissions by five to 20 percent. Splitting the existing traffic stream on Highway 104 into two streams will allow the local traffic on the existing Highway 104 to flow more smoothly while disbursing emissions over a broader area, thereby improving air quality within the existing corridor.

Carbon dioxide is considered a "green-house" gas and construction of the realigned Highway 104 will reduce overall carbon dioxide generation by reducing fuel requirements due to the shorter route and more constant operation speed attained. This project has negligible impact in terms of upper-atmosphere ozone deterioration.

7.1.2 Noise Impacts

7.1.2.1 Traffic as a Noise Source

Traffic is classified three ways when evaluating noise generation. These categories include (1) cars and light trucks, (2) diesel trucks and gas-powered heavy trucks and (3) motorcycles.

Noise is generated by several different aspects of vehicle operation. During heavy truck acceleration, noise from the exhaust, engine and fan predominate almost equally but in that order of dominance. In light automobiles, exhaust noise dominates intake noise slightly with fan and engine noise much lower but very nearly equal. Buses are slightly quieter than trucks because the engine is enclosed and better mufflers are used.

Tire noise becomes significant at high speed and often dominates a distant traffic sound because of the frequency of the sound waves generated and the outward radiating directionality of the sound. Motorcycle noise is dominated by exhaust and intake noise followed by engine noise.

7.1.2.2 Construction Equipment as a Noise Source

Construction equipment creates maximum noise levels similar to those generated by large, heavy duty, diesel powered highway equipment. In some cases, slightly higher levels are found as a result of less shielding built into the body of the equipment. In addition, sounds of abrasion or impact may occur but are secondary.

The equipment is seldom concentrated in one location and therefore results in a highly variable sound environment along the portion of alignment under construction at the time. Coincidence of several pieces of equipment can result in extremely high momentary sound levels.

Bridge or embankment construction can result in longer term exposure to noise from compressors, pumps, traffic and earth-moving equipment.

7.1.2.3 Impact Factors

Interference from unwanted sound can impact in three ways. These impacts can include: annoyance, speech interference and sleep interference. Requirements may range from the desire to use telephones, radios or televisions satisfactorily to the desire for a tranquil environment. Early research into the effects of noise concentrated on steady noise

or single event noise occurrences. More recently, research has gone into the effects of noise which is variable or of long duration such as that created by construction or traffic.

National Cooperative Highway Research Program studies of annoyance versus traffic noise have found that in the absence of speech, slight annoyance with noise occurs at L_{eq} noise levels in the range of 45 to 65 dBA while moderate annoyance occurs at levels of 55 to 65 dBA. A very high level of annoyance occurs at levels of from 60 to 70 dBA and extreme annoyance occurs from 70 dBA on up. The range of reactions depends on the individual sensitivities of the receptor and the nature of the noise. For example, at a given L_{eq} , annoyance decreased with the overall variability in the level of the noise.

Studies of noise effects on sleep indicate that continuous equivalent noise levels in excess of 37 to 40 dBA, in a building, will cause sleep disruption while intermittent noises up to approximately 48 dBA are unlikely to cause disturbance. However, at approximately 54 dBA, noise occurrences can cause sleep disturbance. These guidelines will vary according to the receptor.

The location of the receptor has a bearing on reaction as well. More noise can be tolerated outside and response will vary according to the amount of time that receptors spend outside. Noise can be abated between the outside and the inside of a building to a level where little annoyance takes place inside the building. An additional parameter which determines the impact of a change in noise environment is the magnitude of the change from the original levels that the receptors have grown accustomed to.

Slight interference to speech starts at an L_{eq} of 45 and goes on to 65 dBA where the speech is loud enough to allow comprehension. Moderate annoyance starts at 45 dBA going to 60 dBA in situations where comprehension of the speech is only moderate. Very high annoyance can occur from about 50 dBA to 70 dBA, with extreme annoyance taking place at levels above 65 to 70 dBA. Normal voice communication with high intelligibility can take place at 56 dBA while good comprehension for a "relaxed" voice will

occur at 47 dBA. At low levels of noise, annoyance is related more to interference with speech, however, at higher levels (that is, greater than 60 dBA) annoyance is more related to the nature of the traffic noise itself.

Recommended Noise Limits

Criteria for noise impact analysis employ L_{eq} and L_{dn} , setting limits which depend on use of adjacent property and are shown in Table 7-2. L_{dn} is a variation of the L_{eq} parameter and gives greater weighting to noise levels during sleeping hours. Ten dBA is added to noise levels over and above the L_{eq} measured between the period 2200 and 0700 hours.

TABLE 7-2

Criteria for Noise Impact Analysis

Land Use	L_{dn} (dBA)	L_{eq} (dBA)
Residential	55	
Hospital	55	
Motel, Hotel	60	
School buildings, outdoor teaching areas		60
Church		60
Office buildings		70

Note: These levels are outdoor levels, assumptions have been made that typical noise reduction for the type of structure involved will take place and provide an acceptable indoor environment.

A guideline for the impact of increasing noise level based on guideline levels is as follows:

0 to 5 dBA below criterion	-	No impact
0 to 5 dBA above criterion	-	Moderate impact
Greater than 5 dBA above	-	Great impact

An estimate for the percent of residents which will become highly annoyed with changes in environmental noise levels can be derived as follows:

$$\text{percent Highly Annoyed (HA)} = 2(L_{dn} - 50)$$

The expression indicates that where L_{eq} is increased as high as 50 dBA then the percentage of highly annoyed individuals is negligible or zero. However, should L_{dn} be increased to 55, the percentage "Highly Annoyed" become $2 \times (55-50)$ or 10 percent. Should L_{dn} reach 65, then the percent "Highly Annoyed" is significantly higher at $2(65-50)$ or 30%. The expression is provided as a guideline, based on the originating research, and should be interpreted accordingly.

Impacts are also assessed on the basis of the number of people affected by the changes. Therefore, a moderate excess over criterion levels which affect a large number of people exerts a greater impact than a large excess over the criterion which affects only a small group of people.

Predicted Noise Levels

Based on an average daily traffic level of 7000 vehicles, of which 22 percent are trucks and where 15 percent of the traffic takes place during the hours of 10:00 p.m. and 7:00 a.m.; projected L_{eq} levels at various distances from the right-of-way, at a typical level, vegetated site, are as shown in Table 7-3.

Levels of sound in adjacent areas during construction are indicated in the last column. Examining the predicted levels in relation to the criteria given in Table 7-2, it can be seen that noise levels during highway operation will be above the 55 dBA L_{dn} criteria for residential use at distances up to approximately 150 metres. No impact on hospitals or other noise sensitive facilities is foreseen. The criteria for facilities at the level of sensitivity of schools or churches, would be exceeded only at a distance of approximately 50 metres from the roadbed.

TABLE 7-3
Projected L_{eq} Levels

Distance from ROW (metres)	Day	Night		Construction Noise at Source (Max dBA)
	L_{eq} (dBA)	L_{eq} (dBA)	L_{dn} (dBA)	
50	60	55	58	92
100	57	52	55	88
200	53	48	51	83
400	50	44	47	77

Existing day-time L_{eq} levels for the proposed right-of-way range from 23 to 68 dBA. Night-time L_{eq} will be estimated to be between 35 and 50 dBA. As a result, residences within 400 metres of the roadway could experience increases in L_{dn} of from 0 to 23 dBA. Owing to the very quiet sound environment in the existing situation, major impact and significant numbers of complaints can be expected where the roadway encounters existing dwellings along the route.

As seen in Table 7-3, construction noise levels will be relatively high adjacent to the right-of-way. However, residents are generally more tolerant of these levels due to their transitory and temporary nature. The limited number of dwellings within 300 to 400 of the road construction metres will receive some noise impact during construction.

7.2 Impacts on the Aquatic Environment

7.2.1 Surface Water

Impacts on the surface water environment are described first in relation to the types of impacts associated with highway construction and operation, and second in terms of the sensitivity of the specific streams crossed by the proposed alignment.

Both construction and operation of the highway will have impacts on surface waters. Construction impacts are primarily associated with construction practices and environmental control measures employed during construction of the actual water crossing. Operational impacts are primarily associated with runoff from the highway, including sediment and chemicals. Chemical runoff can include leakage from vehicles, accidental spills, or application of chemicals such as herbicides or de-icing agents.

7.2.1.1 Impact of Water Crossings

Construction of water crossings can impact the aquatic environment in the following ways: (Leedy, 1975):

- direct loss of habitat from excavation or infilling;
- alteration in habitat through a change in stream hydrology;
- sedimentation from erosion or poor construction practices;
- impeding fish passage (e.g., by improper installation of culverts); and
- changes in chemistry due to contingency situations or poor construction practices.

Sedimentation of aquatic habitat, particularly salmonid spawning habitat, is generally the major concern associated with highway construction (Platts, 1968). Not only can overwintering eggs be killed from sediment accumulations, but the long term spawning potential of the stream can be substantially reduced by continued sedimentation.

Construction of bridges and culverts can also affect fish populations. Improperly placed bridge abutments can create high velocity barriers to fish and cause erosion downstream. Improper culvert design can also result in high velocities or vertical drops at the discharge end of the culvert that are barriers to fish passage.

Water crossings have been defined for the proposed alignment using 1:50,000 scale topographic maps. Streams smaller than those shown at this scale are considered intermittent and not to provide significant fish habitat; they may, however, provide limited trout habitat during wetter seasons of the year.

Water crossings have been categorized into three classes. The first class represents small and intermittent (ephemeral) streams that do not provide significant fish habitat. The second class represents generally larger streams that provide habitat for rare or endangered species or potential spawning areas for salmonoids, particularly Atlantic salmon. The third class represents particularly sensitive crossings that support valuable fish populations and also have unusual physical features that complicate construction of the crossing.

Small and Ephemeral Streams

Small ephemeral streams include crossings identified in Section 6.4 (Figure 6-10 and Table 6-10) as well as other small streams not shown on 1:50,000 mapping. Some larger streams that provide poor fish habitat, frequently because of extensive beaver activity within the watershed, are included in this class of crossings. A few of these streams (crossings 3 and 11) support blacknose dace. While this species is uncommon in Nova Scotia, it is common throughout eastern North America and its presence was therefore not considered sufficiently important to warrant placing this crossing in a more sensitive class. This class of crossings include:

- crossing 1, an unnamed tributary of the Burntland Brook;
- crossing 3, Tillits Brook;
- crossing 7, unnamed tributary of the West Branch Wallace River;
- crossing 8, tributary to Gleason Brook;
- crossing 11, Spencer's Brook;
- crossing 13, Moose Brook; and
- crossing 15, Peppard Brook.

While sensitive fish habitat is not present within the proposed highway corridor, important fish resources downstream are still at risk from sedimentation. However, existing construction guidelines should be adequate to protect these downstream resources.

Major Streams

Salmonoid spawning habitat or Atlantic salmon are present within the highway corridor of all water crossings placed in this class. These crossings include:

- crossing 4, unnamed tributary of West Branch Wallace River;
- crossing 5, unnamed tributary of West Branch Wallace River;
- crossing 6, unnamed tributary of West Branch Wallace River;
- crossing 9, main channel of the Portapique River;
- crossing 10, Matheson Brook;
- crossing 12, Cumberland Brook;
- crossing 16, main channel of the Folly River; and
- crossing 17, main channel of the Debert River.

At many of these crossings, valuable spawning habitat is located at the crossing site. In others, spawning habitat is located downstream of the crossing within the corridor. Unless sedimentation is minimized during construction of these crossings, significant loss of

salmonoid spawning habitat could occur. Construction in the stream (e.g., construction of bridge piers or abutments) could also destroy spawning habitat. Maintenance of adequate fish passage is also of concern at all these crossings.

Particularly Sensitive Crossings

Two crossings are judged as particularly sensitive and in need of specific mitigating measures. These are crossing 2 at Burntland Brook and crossing 14 of the Great Village River.

The crossing of Burntland Brook is particularly sensitive because the brook provides salmon habitat, is associated with a large fen, and forms a major headwater tributary of the River Philip. Normal crossing procedures would likely involve infilling of a substantial portion of the fen, which could significantly alter the stream and wetland hydrology, and affect stream flows, and possible, water quality downstream.

The crossing of the main channel of the Great Village River as described in the foregoing sections is particularly sensitive because of the high cliffs bordering both sides of the river. While the proposed centerline crosses through a pool rather than a spawning area, it is likely that conditions at this crossing will either require a shift in the alignment or unusual construction methods. Such a change is in fact proposed as a mitigative measure in Section 8.4 and described in Appendix 2. The importance of the fish habitat, particularly salmon habitat, in this river and the uncertainty surrounding the type and construction of the crossing, places this crossing in the most sensitive class.

7.2.1.2 Highway Runoff Impacts

Storm water runoff from the highway has the potential to have the greatest long-term impact on the aquatic environment. Runoff can contain numerous chemicals, including metals and hydrocarbons, released from vehicles travelling the highway. Many of these constituents may be bound by sediments and not directly affect aquatic resources.

However, runoff from high volume highways in the US (185,000 vehicles per day) has been shown to be toxic to some aquatic species, including algae and fish (Dupuis et al., 1985). In general, runoff from moderate volume highways (approximately 10,000 vehicles per day) can have stimulatory effects, rather than inhibitory (Ibid.). Soluble copper and zinc have been identified as the most toxic constituents in some highway runoff.

De-icing agents appear in highway runoff during winter in addition to potentially hazardous chemicals. The application of de-icing agents has been frequently shown to increase salt ion concentrations in nearby soils and water. The effects are less pronounced for stream and rivers, where increased flows during storm and melt conditions have sufficient dilative capacity to minimize increases in salt concentration to keep chloride levels well below 250 mg/L (Dupuis et al., 1985). In some cases, salts have been shown to persist in streams for months following the termination of winter salt applications (Demers and Sage, 1990) and to accumulate in lakes and wetlands. Increased salt concentrations (greater than 1,000 mg/L chloride) in streams have been shown to increase the drift of benthic macroinvertebrates (Crowther and Hynes, 1977). Increased drift refers to larger numbers of invertebrates floating downstream and does not necessarily imply mortality, although these organisms are more available to be preyed upon by fish. These concentrations of salt has also been shown to decrease the biomass and diversity of algal species (Dickman and Gochnaver, 1978). However, lower concentrations of salt (less than 1,000 mg/L chloride) tend to have a stimulating effect on most biota and are unlikely to have any significant negative effect in short-term exposure (Dupuis et al., 1985).

Fish are quite tolerant of salt. For example, rainbow trout sustained only a 20 percent mortality when exposed to 12,000 mg/L sodium chloride, and some fish can tolerate 10,000 mg/L without apparent effect (Sharp, 1971).

Chemical de-icing agents used on highways often include a variety of additives to prevent caking or inhibit corrosion. The most common of these are the anti-caking compounds ferric ferrocyanide (or Prussian blue) and sodium ferrocyanide. Ferric

ferrocyanide is insoluble and relatively low in toxicity. For example, it has been reported that a concentration of 9,600 mg/l of Prussian blue had no adverse effect on minnows in a 48-hour bioassay (Dupuis et al, 1985). Sodium ferrocyanide, conversely is quite soluble and liberates the cyanide ion in the presence of sunlight. The Canadian criterion for cyanide to protect aquatic life is 0.005 mg/l.

Overall, significant aquatic impacts will not occur from the application of de-icing agents; however, concentrated runoff from a large area of highway or large uncovered stockpiles of road salt into a small stream or pond could have a localized impact.

7.2.1.3 Potential Surface Water Supply Development

The Cobequid Mountain Region has the potential for the development of surface water supplies. There are no known plans along the proposed alignment for the development of surface water watersheds for water supply purposes. The proposed alignment crosses the headwater reaches of Burntland Brook and Tillits Creek, tributaries of the River Phillip. Given that Oxford Frozen Foods is using water from the River Phillip, this river system could potentially be developed at sometime in the future as a supplementary water supply for the Town of Oxford. The proposed alignment may therefore place some constraint on the designation of this source, due to the possibility of contingency situations occurring within the watershed; although the existing highway provides the same constraint.

7.2.2 Impacts to Groundwater

Construction and operation of any new highway alignment has the potential to impact on the quality and quantity of groundwater as a result of blasting operations, removal of overburden, excavation of sand and gravel deposits, contamination from de-icing chemicals and contingency situations.

Blasting may have either a negative (ie reduction or loss of supply), positive (increased supply) or nil effect depending on whether water bearing bedrock fractures

become smaller, larger or remain unchanged as a result of inducted seismic blast waves. The majority of the groundwater wells noted in the NSDOE Water Well Records in the study are drilled into bedrock. In the volcanic, granitic and metamorphosed sedimentary bedrock which comprise the Cobequid Highland Massif, groundwater flow is predominantly through fracture flow. Therefore, these bedrock types may potentially be affected by blasting operations in or near the proposed corridor. Groundwater wells drawing water from the sedimentary rocks which underlie the Minas and Northumberland Coastal Lowlands are less likely to be affected by blasting operations than those wells set in bedrock of the CHM. Groundwater movement in these rocks is noted to occur through both pore and fracture flow systems.

Groundwater quality can be impaired through increases in suspended sediment and nitrate levels caused by blasting. Blasting can also influence the flow into bedrock wells. In the vicinity of the proposed alignment, it is expected that any potential effects to existing local wells would be to those relying on fracture flows.

Vibrations from heavy equipment operations can also potentially affect the quality (increased sediment volume) and quantity (reduced or loss of supply if recharge area damaged) of shallow, dug wells tapping water from surficial aquifers. Damage to dug wells generally does not occur at distances greater than 100 metres from blasting or heavy equipment operations.

The use of sand and gravel deposits for construction aggregate represents a very real resource conflict. Deposits that are mined for their aggregate potential cannot generally be used for groundwater supplies because of the probable degradation of the water quality and the dewatering of the deposit during mining operations. In this context, the identification and selection of sources of aggregate for highway construction should take into consideration the potential impact to existing groundwater supplies, as well as the potential for the development of future groundwater supplies, in these sand and gravel aquifers.

Groundwater quality may also be degraded through the exposure of permeable bedrock aquifers to surface contaminants, (road salt, fuel spills, etc.) as a result of the removal of protective overburden during stripping operations. Acid drainage is not expected to be a problem on this alignment.

The application of de-icing salts on highways may have a potential impact on groundwater quality. Elevated levels of sodium chloride have a tendency to increase the ionic strength of the groundwater. Under these conditions, metals such as iron and manganese can be released from the overburden and /or bedrock increasing the hardness of the groundwater to unacceptable drinking levels.

Herbicide application is another maintenance issue which may potentially affect the quality of groundwater wells situated adjacent to the corridor, although this is undertaken only in agricultural areas and at the request of the Department of Agriculture.

Accidental spills or leakages of petroleum hydrocarbon products may potentially affect groundwater supplies during highway construction. Similarly, during operation and maintenance of the highway, accidental spills/leaks of petroleum hydrocarbons and other hazardous substances represent a potential threat to local groundwater supplies. Although the most significant environmental impacts would be to nearby streams and lakes, groundwater may also be potentially affected unless remedial measures are taken quickly and efficiently.

7.3 Impacts on the Terrestrial Environment

Impacts on the terrestrial environment are described first in relation to the types of impacts associated with highway construction and operation, and second in terms of the particularly sensitive habitats found within the corridor.

7.3.1 Types of Impacts

Highway construction can affect plant and wildlife habitat in a number of ways, including (Dale and Freedman, 1982):

- fragmentation of the landscape and, at a smaller scale, ecosystems;
- restriction in movement or migration of faunal populations, including road kill of wildlife;
- alteration of water drainage patterns;
- contamination of bordering vegetation from air emissions, runoff and de-icing chemicals; and
- changes in microclimates.

7.3.1.1 Loss of Habitat

The most obvious effect from highway construction is the clearing, grading and paving of hundreds of hectares of land. Much of this land may have previously supported forests and other wildlife habitat and, although particularly valuable habitat can be avoided, habitat will be lost and the overall carrying capacity for some species reduced. At the same time, the grassed medians and highway edges provide improved habitat for some species such as rabbits. In the end, highways destroy habitat for some species and improve conditions for others (Leedy, 1975).

7.3.1.2 Increased Edge Creation

Increased edge creation is a key factor in the overall impact of highways on wildlife, including birds. Highways break up the more or less uniform forest providing a more diversified habitat (Leedy, 1975). This edge habitat is particularly valuable for some species such as pheasant and may provide improved hunting success for some raptures (Ibid.). However, highway edges also tend to attract parasitical and immigrant species, such as cowbirds and starlings. These aggressive birds then displace many types of warblers, thrushes, flycatchers and the like from the edge zone.

7.3.1.3 Wetland Hydrology

Highway construction can affect both hydrological and biological components of wetlands. Wetlands can be hydrologically open systems (with surface water input and/or output) or closed systems (no surface water outflow). Wetlands have been shown to be important hydrological recharge areas and, in the case of hydrologically open systems, can be important in flooding control (Niering, 1968). Marshes have also been shown to act as sinks which trap nutrients from surrounding terrestrial systems (Less, 1970; Kadlec, 1979). They retain and regulate nutrients in the thick organic substrate and plant biomass. Extensive fills and deep cuts can cause the following hydrological changes (Dupuis et al., 1985):

- beheading of aquifers;
- draining of wetlands where cuts extend below the water table;
- changes in ground and surface water divides and basin areas;
- reduction in induced streambed infiltration due to sedimentation;
- obstruction of groundwater flows; and
- changes in runoff and recharge characteristics.

In addition to effects on the wetlands, changes in the hydrology of wetlands can affect the hydrology of the downstream portions of the watershed in terms of flows and water chemistry.

7.3.1.4 Post-Construction

Increased access into the study area will probably have the most significant impact on forest cover and wildlife. It will allow increased agricultural and recreational development, hunting and forest harvesting, as well as non-consumptive uses such as bird watching. Other post-construction impacts include mortality of wildlife from road kills, and localized poisoning from concentrated runoff containing hazardous or de-icing chemicals.

The fact that wildlife are killed by vehicles travelling highways is apparent to anyone travelling the roads. However, it is probable that, for most species, the loss is not

significant, because of the relatively small proportion of the ranges of the respective wild animal species affected by the highways (Leedy, 1975). The impact of road kills, however, can be significant where a highway intersects a migration route, particularly for rare or endangered species. For example, a number of populations of sea turtles have been endangered by coastal development, including road construction, in the US (National Marine Fisheries Service, 1975). Perhaps more important is the potential for human injury or death if vehicles at high speed hit big game. Collisions with animals, including big game, will no doubt occur on the new highway, but the overall risk to motorists or wildlife is considered small and comparable to many sections of other existing highways in Nova Scotia.

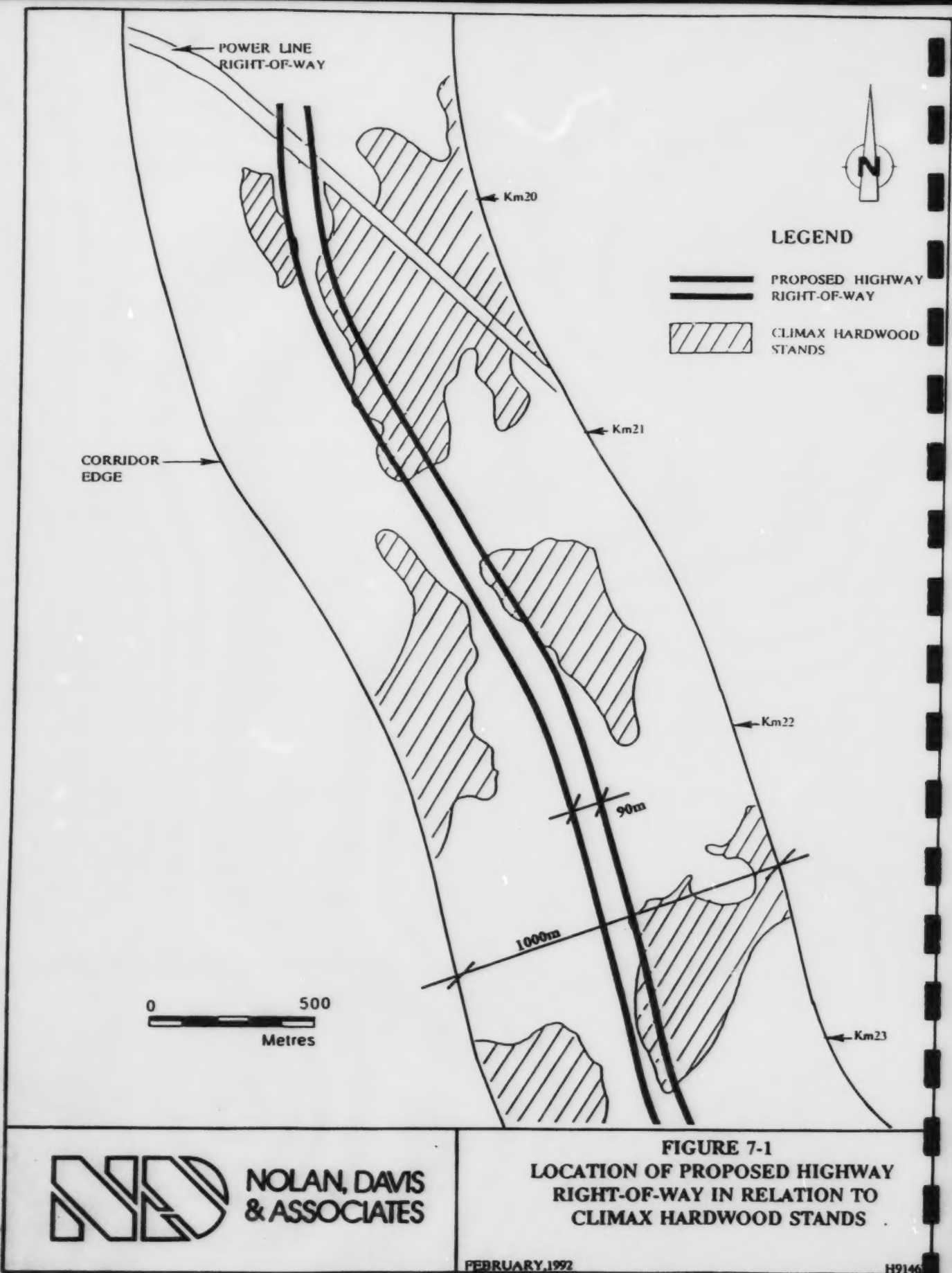
Direct poisoning of wildlife by highway runoff can occur, but it is generally limited to roads with higher traffic volumes than will be present on this highway (Dupuis, 1985). Salt poisoning of wildlife has occurred, but it was found to be limited to highly stressed wildlife populations (Trainer and Karstad, 1960). Some plant species, including white pine, hemlock, sugar maple, red maple, and most ornamentals, are sensitive to salt and will likely disappear from near roadside environments over time (Adams, 1973). Contamination from highway chemicals is generally limited to a short distance from the highway; for example, Motto et al, (1970), found that increased lead concentrations in plants were limited to a zone within about 30 metres of the highway.

7.3.2 Particularly Sensitive Features

7.3.2.1 Climax Hardwood Stands

The north and south slopes of the Cobequids contain stands of climax and near climax hardwoods that are uncommon in Nova Scotia. These areas are particularly important because of the diversity of species found in them, including rare and endangered species, and the stable nature of this type of forest community. If undisturbed, these stands will maintain themselves indefinitely.

In general, the proposed alignment minimizes the disruption of these hardwood stands. For example, Figure 7-1 illustrates the proposed highway alignment within



the corridor between kilometres 20 and 23. The centerline runs midway between the largest concentration of climax hardwood stands found within the corridor. While a small portion of the stands will be destroyed by highway construction, it is not clear that a shift in alignment would decrease the impact. The proposed alignment also tends to minimize the increase in edge habitat because it tends to follow the existing stand borders. Nonetheless, some of this valuable climax hardwood forest will be lost. In addition, contamination from road salts and other chemicals will gradually affect the portions of the stands nearest the highway, decreasing the relative abundance of sensitive species like red and sugar maple.

Climax hardwood stands are cut by the proposed alignment at kilometre 10 and between kilometres 13 and 14. In both cases the highway centerline would clear these stands if shifted about 100 metres to the west.

7.3.2.2 Wetlands

The highway passes through a large area of wetlands in the northwest portion of the study area. In general, the proposed alignment already minimizes the number of wetlands intersected and changes in alignment within the corridor would not significantly change the overall impact on wetlands. None of the wetlands are considered valuable as waterfowl habitat, but they in all likelihood play a role in stabilizing stream flows and reducing sedimentation.

One large treed bog, located west of Atkinson, is a special case. The centerline of the proposed alignment passes through an unusually deep (over six metres) portion of the bog. Construction of the highway through this portion of the bog might require substantial infilling of the bog, affecting the quality of the bog and, potentially, downstream hydrology. The remainder of the bog is relatively shallow (approximately two metres) and it would substantially reduce the impact on the bog, as well as construction costs, if the highway alignment was shifted approximately 200 metres.

7.3.2.3 Wildlife

The new highway will pass through big game overwintering areas; both deer and moose are relatively plentiful over much of the highway corridor. Some big game habitat will no doubt be destroyed, but a biophysical inventory indicated that few areas of good overwintering habitat occur within the actual highway corridor. If sensitive older stands of hardwood are preserved, the impacts on the majority of other wildlife species should be minimized.

Only small amounts of sensitive habitat are found in the study corridor, and impacts on bird population in the area are likely to be minor.

Amphibians, like the four-toed salamander and numerous species of frogs, are dependent on wetland habitat. Because the highway passes through a large area of wetlands, amphibians may be more adversely affected than other species.

7.4 Social Impacts

7.4.1 Impacts to Cultural Resources

The normal construction activities will in all likelihood impact on a number of the historical and cultural resources recorded during the Phase II study. However, the significance of these sites as they relate to the history of Nova Scotia is judged to be minor. At the present time there are no guidelines to assess historical and cultural significance of archaeological sites that fall under the mandate of the Special Places Protection Act (1980). Recent discussions between the archaeological community and representatives of the Nova Scotia Museum have identified criteria which could be used in determining significance. These include:

1. Age of the resource
2. Present condition of the resource
3. The potential of the resource to contribute to knowledge

4. Uniqueness of the resource
 - a) Resource type
 - b) Function
 - c) Historical association
5. Public Interest

With one exception, [the Rushton Pioneer Cemetery (1991 NS 22-3)], all of the remaining historical and cultural resources identified would be ranked low on any scale using these criteria. In age they comprise mid-nineteenth to mid-twentieth century farmsteads. Although, in their present condition they are pristine for the purposes of archaeological excavation, this is also true for hundreds of similar sites, many still standing and working farms, throughout the province. At this time, farmstead sites have not been the major focus of archaeological enquiry. In part this is due to the existing structures and the volumes of archival and other forms of historical documentations available for interpreting this period of Nova Scotia's history. At some time in the distant future they may become a more significant heritage resource, however, given their present numbers it is our opinion that they would not contribute substantial new information on the nineteenth century occupation of Nova Scotia. Given this, they are not considered as unique resource sites either in type or function. An extensive archival search along with informant interviews did not identify any significant historical associations of the sites that may be impacted. The only expressed public concern was with the Rushton Pioneer Cemetery. Thus it is the professional opinion of Davis Archaeological Consultants Limited that no significant historical or cultural features will be lost during the construction of the proposed Highway 104. However, the area immediately around the Rushton Pioneer Cemetery should be considered as a sensitive zone (see Section 8.7).

7.4.2 Personal and Community Impacts

The relative absence of communities and population along the proposed highway corridor means few individuals will be directly impacted as a result of the highway construction and use. Nevertheless, those who do live along the route will clearly be affected by a new highway passing through or near their property.

Views about the impacts of the proposed highway were obtained from owners of occupied residences and businesses situated within 500 metres of the alignment through in-person interviews conducted in 1991 as part of the Environmental Screening Study. This information provides an accurate assessment of how those situated along the highway corridor believe the new highway will affect them and their community. (Complete documentation of this research is provided in Chapter Three of the Environmental Screening Report prepared by Nolan, Davis & Associates, August, 1991).

A majority of owners of occupied households and businesses along the highway alignment indicated that the overall impact of the new highway would be very (31 percent) or somewhat (23 percent) negative on themselves or their property, while a minority anticipated the impact would be somewhat (11 percent) or very (17 percent) positive. The types of reasons given for anticipating a negative impact include increased noise from highway traffic (disrupting the peaceful character of the area), the loss of some or all of their property and general disruption of current land uses and quality of life. Those who thought the highway would have a positive impact either didn't expect to be living in the area by the time it is built, or considered that the benefits of a new highway outweigh its costs. Although many local property owners expressed concerns about negative impacts of the highway crossing near or on their land, almost everyone (88 percent) interviewed said it was very important that a new highway be built to replace the existing one.

Owners of residences and businesses along the corridor were also asked how they thought the new highway would affect the value of their property. Most believe the highway will cause the value of their property to decrease significantly (40 percent) or

somewhat (11 percent) once it is built, while few anticipate the value will increase (17 percent) or remain essentially the same (26 percent).

Almost half indicated they would definitely (40 percent) or likely (9 percent) move elsewhere if the highway was built along this alignment, and half (51 percent) of this group anticipated that they would have a great deal of difficulty in making such a move (a response most widely given by owners of agricultural properties and long time residents). Three in ten (31 percent) of the businesses located along the alignment said construction of the new highway would require them to relocate, and half (50 percent) of this group felt they could successfully reestablish their business in another location.

Property owners along the alignment were also asked how they felt the new highway would affect their local community or area. As with personal impacts, most believe that the new highway would have a very (31 percent) or somewhat (35 percent) negative impact on their local area. Some of the reasons given for this view relate to social or community disruption (loss of population, lower quality of life), while concerns were also expressed about the impacts of the highway on local businesses, environmental quality and wildlife in the area. Those who believe the highway will have a positive impact on their community stressed the improved access to the province's highway system, the boost it will provide to local businesses through better access and increased traffic, as well as the obvious benefits of having a safer highway.

The public perception study also surveyed a representative sample of residents and businesses living in the area but not directly along the alignment, including the communities of Glenholme, Great Village, Debert, Masstown and Lower Onslow. When asked about the impact of the new highway on their own community, most residents and businesses said the impact would either be positive (48 percent) or have no net impact (22 percent). Those expecting a positive impact mentioned the benefits of a safer highway, a boost to local businesses and jobs, and improved access from nearby communities. Those predicting negative impacts expressed concerns about disruption to the local economy, that

some people would lose their homes and the impact the highway might have on the overall quality of life.

Property owners along the proposed alignment also rated the expected impact of the new highway on their community in seven specific areas. Negative community impacts were most likely to be anticipated in terms of environmental quality (63 percent) and agriculture (57 percent) in the area, while less than half predicted that the highway would have a negative impact on the local area economy (46 percent), the stability of the population (46 percent) and the overall quality of life for residents (43 percent). Fewer expect negative impacts on either heritage and cultural resources (26 percent) or tourism and recreational opportunities (12 percent) in the area.

Area residents and businesses not directly along the alignment were decidedly more positive about the impact of the highway on their community, with few anticipating negative social impacts in terms of the quality of life (19 percent), the stability of the population (21 percent), the local area economy (18 percent), heritage and cultural resources (11 percent) or tourism and recreation opportunities (11 percent). Overall, residents living near the highway but not along the alignment were generally positive about the prospect of the new highway, judging benefits to clearly outweigh the costs.

It is important to note that these results accurately reflect local residents' perceptions and concerns about the potential impacts of the new highway, based on the information about the project available at the time. The types of concerns expressed by owners of property along the alignment are typical of those which are voiced by residents of other rural communities faced with the prospect of a new highway being built through their property.

7.4.2.1 Property Values

The impact of the proposed alignment on residential property values near the proposed route is contingent on a number of factors. Typically, residential property values

decrease at the start of such as project due to the nature of the construction-related activities such as increased noise and dust levels. However, after the undertaking becomes accepted as functioning and useful component of the social environment, residential property values tend to rebound. Due to the very low density of residences directly affected by the new alignment, the collective impact on residential property values is expected to be minor.

The value of commercial properties on the existing highway may be adversely impacted due to the loss of traffic, although if the Wentworth area is able to achieve its objective of becoming a recreational and retirement oriented community, the value of both commercial and residential properties could increase to reflect this.

7.4.3 Economic Impacts

The project should provide a number of positive economic impacts to the Province and to the region which include the following:

- Provision of a vital link in the highway upgrading policy of the Province relative to the transport of commercial goods and tourism.
- Long term savings in fuel and vehicle emissions due to it being a shorter route of improved standard than the current equivalent section of highway.
- Reduction in the economic and social loss associated with highway accidents.
- An opportunity for the residents of the Wentworth Valley to develop their area as a tourism/recreational economy in accordance with the objectives expressed by many residents in the Phase I Public Attitudes Survey.
- Enhanced access to the West Colchester Shore area.
- Opportunities for the development of modern highway service related businesses near access points to the highway including Masstown, Glenholme, Thomson Station and possibly in the vicinity of other interchange locations along the alignment yet to be established.

These positive impacts have not been quantified but are likely significant both in absolute terms and relative to properly mitigated potential negative impacts associated with the project.

There will be a significant drop in through traffic along the Wentworth Valley which may result in some negative economic impacts to individual businesses situated on the existing route which are reliant on vehicular traffic for their business. In some cases adjustments will be possible over a period of time so as to address the shift from through traffic to tourism/recreational demands projected for the Wentworth Valley in the future.

Residents of the North Shore area have opposed the proposed alignment on the grounds that it misses an opportunity to enhance economic development in this area. However, this cannot be considered as a negative impact because the existing level of access to the North Shore area will be maintained and possibly even enhanced by upgrading existing highways in the future.

7.4.4 Impact on Safety

Changing from a two lane undivided highway configuration to a divided highway will result in a major decrease in injury and fatal accidents, as indicated by the provincial statistics presented in Table 7-4.

TABLE 7-4

Typical Accident Rates
(100 Million Km Driven)

	<u>Injury</u>	<u>Fatal</u>
4 lane divided highway	9.5	0.5
2-lane undivided highway controlled access	18.5	1.6
2-lane undivided highway	22.1	2.0

Source: NSDOTC

The disruption and personal impacts, as well as the cost, of these accidents is significant.

Climate has obvious implications with respect to highway safety, particularly during the winter months. In particular, visibility (fog/blowing snow) and road conditions (snow/freezing rain) are important factors.

At present, severe accidents are experienced on the existing undivided highway as a result of excess speed, inattention and/or roadway conditions which cause vehicles to collide with on-coming traffic. Accident experience with divided highways tends more to involve ditching of vehicles during poor traction conditions with lesser resulting injuries and fatalities.

The slightly higher and more prolonged elevations on the proposed western route may result in slightly greater wind and snowfall on the route than would be experienced on the existing roadway. However, given the capabilities of modern snow-clearing equipment and a roadway designed to minimize the effects of snowfall, these factors will not significantly detract from the much safer character of a divided highway.

Truck drivers prefer foggy conditions to those of heavy snow, slush and freezing rain for the reason that operators can adjust their driving for foggy weather but have greatly reduced control of their vehicles under icy conditions. In that respect, the longer relative proportions of the route on the coastal plain compared to the existing route, will be of benefit to professional drivers.

When the area is experiencing an entrenched weather system, road conditions will be consistent over the whole region including the old route and the proposed route. However, during transitional conditions the overall safety of travel on the new route will be significantly improved over the existing one. Possible additional snowfall and wind that might be experienced over the more prominent highland portion of this road and possible

additional fog on the lowlands, will be counterbalanced by the use of modern snow-clearing equipment, the friendlier geometry of the new alignment, the fact that it is a divided highway, and a possible lower incidence of icy conditions on the coastal portion of the road.

7.5 Impacts on Land Use

The potential direct impacts to land-use include the loss of valuable acreage, fragmentation of holdings and possible reduced accessibility. Other less well defined potential impacts may be expressed in the form of reduced biological activity due to vehicular emissions, dust and the runoff of greases, oils, salt and other contaminants. Land productivity may also be impacted by alterations in drainage patterns which could reduce water availability or induce flooding, although careful design should minimize these problems.

Assuming that the present centerline is adopted for highway construction and that the right-of-way width will be 90 metres, approximately five hectares of blueberry bushes and 10.4 hectares of existing agricultural land will be taken out of production. Noteworthy fragmentation (greater than three hectares not accessible by existing infrastructure) of existing fields occur at two sites along the alignment as identified by Figure 6-16.

The potential loss of agricultural land in the area near Great Village was instrumental in the decision to consider a change in the alignment of the highway in this area so as to mitigate this potential impact. The changes to the route proposed and its resulting impact are described in Appendix 2.

7.5.1 Loss of Agricultural Productivity

Loss of productivity in managed land use situations may result from the direct impact of runoff and air-borne contaminants in the immediate vicinity of the proposed highway, and from the application of contaminated irrigation water to lands downstream of the alignment.

A study is presently underway to assess the impact of salt runoff and air-born spray on the productivity of blueberry bushes. A producer, located on the existing Highway 104 near Folly Mountain, is working in collaboration with the NSDOTC and the Department of Municipal Affairs in an attempt to quantify the loss of productivity caused by winter highway maintenance activities. It is anticipated that a preliminary set of results will be available after the 1992 harvest season. This is the first study of its kind with respect to blueberries. A limited number of similar studies have been conducted for other crops (Jack Sibley pers. com.).

One specific area of potential impact is a large strawberry producing operation located north of Glenholme and downstream of the alignment. The operation is at some risk of having its irrigation reservoir impacted by highway runoff. Specific mitigation alternatives are presented in Section 8.9.1.

7.5.2 Land Fragmentation

As part of the design process for controlled access highways, each property is investigated in an effort to determine the impact which fragmentation will have on continued use. When fragmented parcels are of a size that they no longer conform with the current use of the property the Department will consider acquisition. If the fragmented section is adequate in size and required by the landowner, then an alternate means of access is provided. This is usually accomplished by an additional road parallel to the highway or by upgrading existing access roads.

Because this form of access may cause some inconvenience and loss in the value of the property, compensation is normally provided by NSDOTC on a negotiated basis.

7.5.3 Recreation

Potential negative impacts to recreational land-use range from aesthetics (eg. disruption of scenery, increased noise), to actual physical disruption of recreational trails (eg. hiking, skiing, snowmobile). The alignment passes quite close to the Elm River Park, which

suggests that there will possibly be some noise impacts to the park. However, the existing Highway 104 also passes close to the camping area on the southern side. Potential impacts can therefore be characterized as a change in the direction of the noise source.

The alignment should be sufficiently removed from Sutherland Lake that there will be little, if any, impact to the enjoyment of these environments. Snowmobile trails radiating from the Lake area will be disrupted by the alignment. An evaluation of use patterns may be warranted to determine whether special underpass culverts or similar facilities are warranted.

7.5.4 Future Land Use

The construction of a new highway alignment in a currently undeveloped or rural area could result in changing land use patterns over a period of time due to the opportunities it provides for improved access. How such changes might occur is hard to predict at this time as they will inevitably be realized gradually, over a period of many years depending on what opportunities are recognized and whether or not they are realized.

The location of interchanges along the route will have some influence in this regard as discussed in the following section.

7.6 Impacts Associated with Interchanges

As indicated in Figure 2-1, there are five potential interchange locations being considered for the new section of highway. NSDOTC are currently proposing interchanges east of the Thomson Road overpass, at Glenholme and at Masstown. Two other possible interchange locations are being considered at the Wentworth-Collingwood Road and at the Station Road, west of East Village.

The interchanges at the Thomson Road overpass, Glenholme and Masstown will be designed to allow movement of traffic between the existing Highway 104 and the new, four-lane Highway 104. Interchanges at Glenholme and at Masstown will have the added

purpose of providing ease of access to the approximately five kilometre long service area between Glenholme and Masstown (see Section 5.0).

The current traffic volume west of Thomson Station on the existing Highway 104 is approximately 7300 AADT and between Glenholme and Masstown is approximately 10,500 AADT, as indicated by NSDOTC figures in Table 6-18. When opened, the proposed new, four-lane divided Highway 104 between Thomson Station and Masstown is expected to carry approximately 6000 AADT. Subsequently, the traffic volume on the existing Highway 104 in the Wentworth area should be significantly reduced to approximately 1200-1300 AADT, and traffic volumes in the Glenholme to Masstown service area should also be significantly reduced to approximately 4000-4500 AADT.

With possible construction of interchanges at the Wentworth-Collingwood Road and at the Station Road, these two roads could have relatively significant increases in their traffic volumes, and thus increased potential for development. The Wentworth-Collingwood Road and the Station Road are paved roads with classifications and design standards sufficient to carry out the expected traffic volumes.

The new Highway 104 will have a posted speed of 100 Km/hr. Presently posted speeds on minor roads and the existing Highway 104 will be retained.

Specific studies on the impact of the interchanges were not conducted because details of the layout and/or location were not available during the Environmental Assessment.

7.7 Impacts from Accidental Events

Construction and operation of a highway can result in impacts arising from contingency situations such as hydrocarbon spills during construction or the release of hazardous materials as a result of traffic accidents during the operation of the highway. Fire may be an additional risk associated with some accidents.

Because of the wide variety of materials carried on the highway, specific impacts resulting from, accidents are difficult to predict contamination of surface and groundwater is always a source of concern in this regard. However, the risk and extent of any impacts associated with fuel spills etc. during the construction stage can be minimized by the application of good management practices as described in Section 8.10.

7.8 Summary/Overview of Impacts

Construction and operation of the proposed alignment will have both positive and negative impacts. These have been identified and reviewed in the foregoing sections and can be summarized as follows:

7.8.1 Positive Impacts

The project, once complete, will reduce the current driving distance between Thomson Station and Masstown by approximately ten kilometres and provide a divided highway of 100 Series standard. In addition to providing modern highway access to, and through, the Province, these attributes should result in reduced traffic accidents relative to the existing situation thus saving lives, injuries and property damage as well as a proportionate saving in fuel consumption and vehicle emissions for the life of the project. The operational costs and fuel savings presented in the Interim Report/Screening Study for the route alternatives are repeated in Table 7-4. These figures provide some perspective into the accumulative impact of operational costs over a period of time and thus the benefit of a more direct alignment. Other positive impacts of the project include the opportunity it provides to the residents of Wentworth Valley to develop the area as a tourism/recreational based economy in accordance with the objectives expressed by many residents in the Phase I Public Attitudes Survey. The project also provides opportunities to enhance access to the West Colchester Shore which was seen to be an advantage by residents in the Phase I survey.

This alignment provides an opportunity to develop a very positive driving experience for tourists entering the Province if the design details take advantage of the view

plains from the Cobequid Highland section of the route.

7.8.2 Negative Impacts

The negative impacts of the project identified as a result of this study are shown graphically in Figure 7-2. This matrix readily indicates that the majority of project activities have no, low or mitigatable impacts on the environmental elements reviewed.

TABLE 7-5
Operational Costs and Fuel Savings

Route	Construction Cost \$ million	Present Value of Operation Costs (Est. 1995-2019) \$ million	Total Cost \$ million	Fuel Consumption (Est. 1995-2019) litres
Eastern	121	1,527	1,648	803,000,000
Central	111	1,298	1,409	683,000,000
Registered	123	1,478	1,603	777,000,000
Western	113	1,374	1,487	722,000,000

Note: Construction cost data provided by NSDOTC

Activities showing significant impacts that are non-mitigable center primarily on contingency situations such as fuel or other hazardous material spills during the construction or operational phase. Other potentially significant impacts of concern include the effects of de-icing chemicals (ie. rock salt) on surface water, agricultural land and possibly also wetlands. The assessment shows that the environmental elements most likely to be impacted, and for which there appear to be little or no opportunity to apply mitigation, to be the following:

FIGURE 7-2

Summary of Negative Impacts

PROJECT ACTIVITY	AIR		WATER			LAND			SOCIAL		
	AIR QUALITY	NOISE	SURFACE WATER	GROUNDWATER	FISH	CLIMAX HARDWOODS	WETLANDS	WILDLIFE	CULTURAL RESOURCES	LAND USE	SOCIAL
<u>Planning/Activity</u>											
Access/Surveying											•
Environmental Assessment											
Property Aquisition										○	○
<u>Construction Phase</u>											
Clearing	•	•	○	●	○	●	•	•	•	○	●
Grubbing	•	•	○	●	○	•	•	•	•	○	●
Blasting	•	•		○				•	•	○	●
Excavation	•	•	○	●	○		●		•	○	
Fill Operations	•	•	○	●	○		●		•	○	
Stream Crossings			○		○		•				
Paving	•		•								
Contingencies - spills, etc.			●	●	●		●	•		●	●
<u>Operational Phase</u>											
Snow Plowing			•		•		●	●			
Salting		•	●	•	•	●	•			●	
Runoff			●		•		•				
Traffic Impacts		•	●	●	●			●	•		•
Bridges Culverts Maintenance		•	○		○		○				
Pavement		•									
Contingencies - spills, etc.			●	●	●	•	●	•		•	•

Key:

- Low Impact
- Significant Impact, Mitigable
- Significant Impact, Non-mitigable
- Significance of Impact

- climax hardwoods in the right of way;
- agricultural land, including blueberry fields, in close proximity to the right of way; and
- surface water and fish in contingency situations or as a result of any failure to implement mitigative measures during construction or maintenance operations.

The impacts, both positive and negative, associated with the construction of interchanges along the alignment have not been evaluated as a function of this assessment, due to the unavailability of detailed mapping or finalization of interchange details and locations, although it has been assumed that there will be interchanges at Thomson Station, Masstown and Glenholme, plus possibly two intermediate locations yet to be defined.

PART 8

MITIGATIVE MEASURES

8.0 MITIGATIVE MEASURES

8.1 Mitigation of Climatical Impacts

A potential concern relative to safety and the driveability of the proposed section of the highway is the impact which blowing snow might have on the Cobequid Uplands section of the route. As reported in Section 6.3.2.1, this region receives higher annual precipitation and snowfall than other portions of northern Nova Scotia as well as a predominance of north and west quadrant winds in winter. The elevation of this section of the highway will inevitably increase the incidence of snow and blowing snow conditions as compared to the lower lying sections.

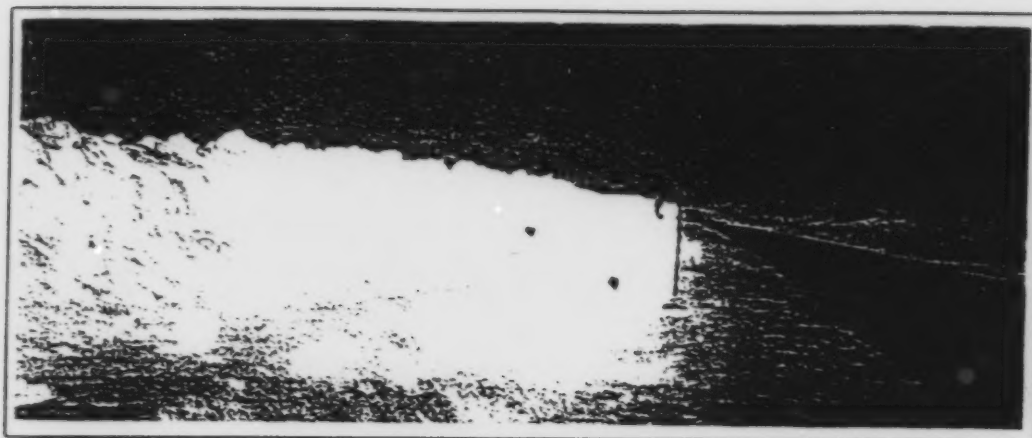
Due to these known characteristics, careful consideration will be given to the detailed design of snow control measures in the upland sections of the route so as to both reduce snow removal costs and improve safety. Such mitigation will centre on the design and construction of properly placed snow fences as well as ensuring that the geometry of the highway and its borders are not conducive to snow accumulation.

In general terms, these mitigative measures are based on reducing the wind speed across the highway so that snow is deposited off the roadway surface due to the loss of snow saltation. A fence must have the proper degree of porosity, usually about 50 percent; be located at the correct angle relative to the predominant wind direction and provide sufficient storage volume for deposited snow between the fence and the highway. (Tabler & Assoc., 1991).

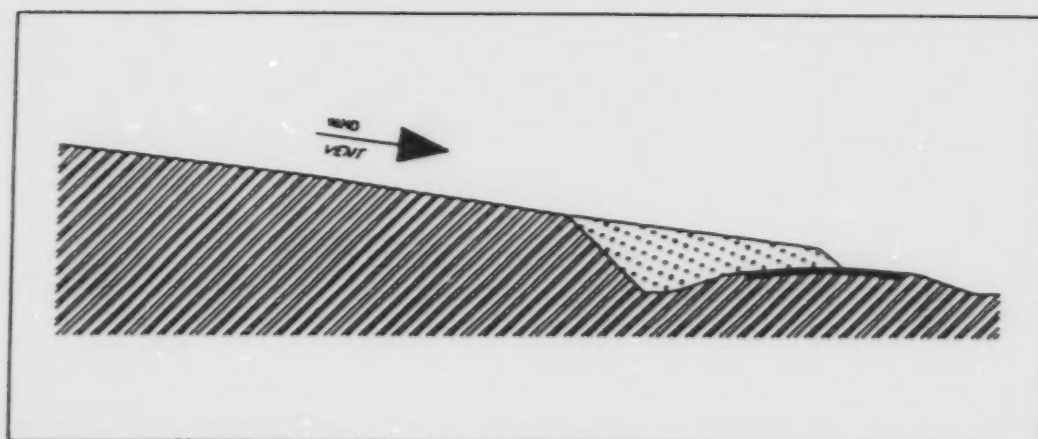
Typical examples of what can be achieved in terms of highway geometry and snow control measures are shown in Figures 8-1 to 8-6 (RWDI, 1992).

8.2 Mitigation of Air Emissions

Any emissions such as vehicle exhausts, burning of slash and fugitive dust will be mitigated at source, although if normal operating practices are applied, there should be little or no requirement for additional measures. Factors to be considered to minimize the

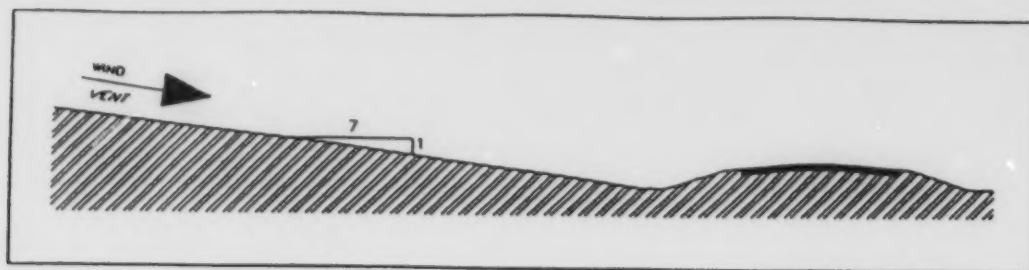


Problem - Snow Accumulation in Single Upwind Cut



Problem Caused by Upwind Cut

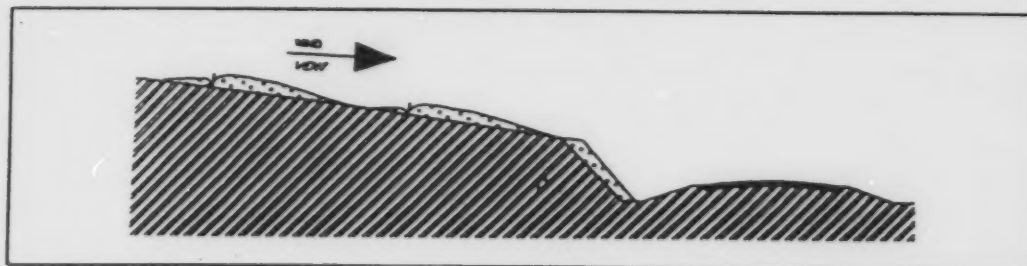
FIGURE 8-1



Solution - Regrade Backslope to 7:1 or less



Solution - Terrace Backslope



Solution - Add Snowfence(s)



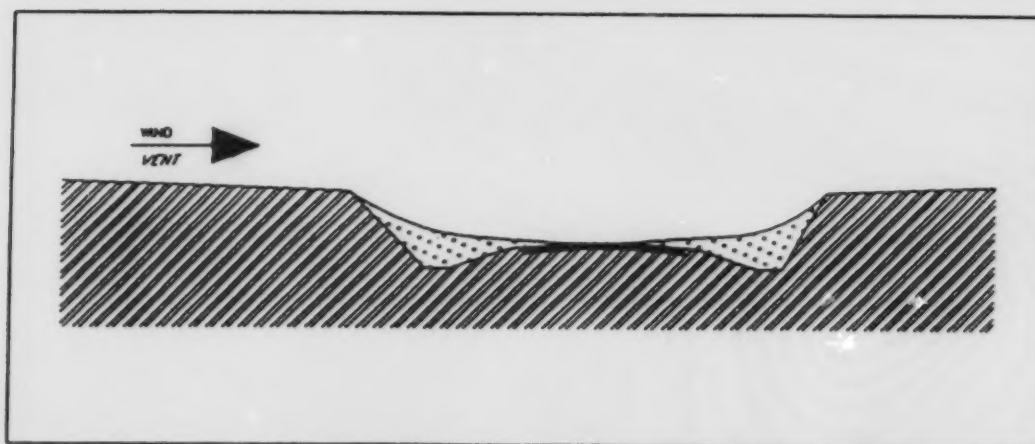
Solution - Add Landscaping

FIGURE 8-2

SOLUTIONS FOR PROBLEM CAUSED BY UPWIND CUT

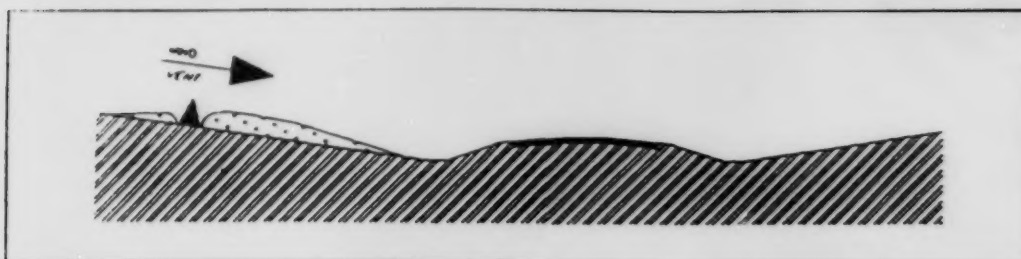


Problem - Snow Accumulation in Double Cut

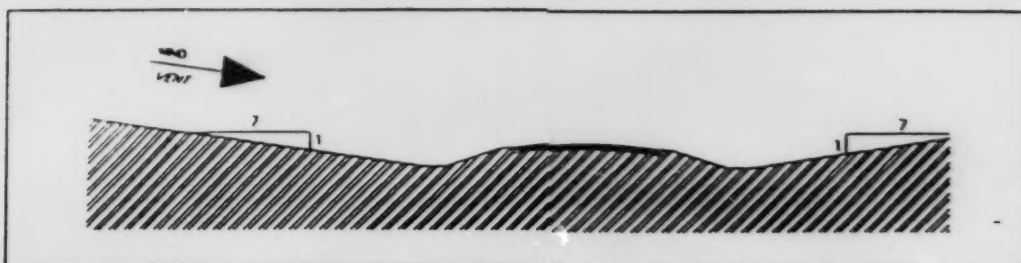


Problem Caused by Double Cut

FIGURE 8-3



Solution - Regrade & Landscape



Solution - Reduce Backslope to 7:1 or less



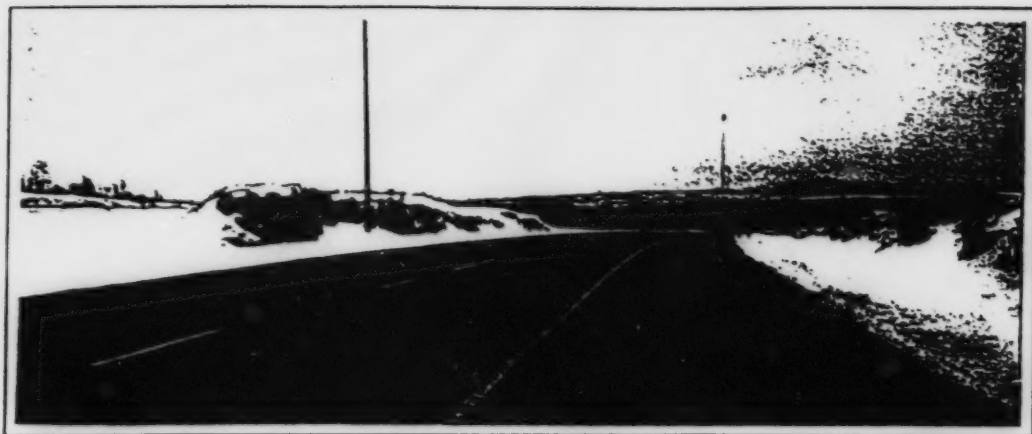
Solution - Regrade & Add Snowfence(s)



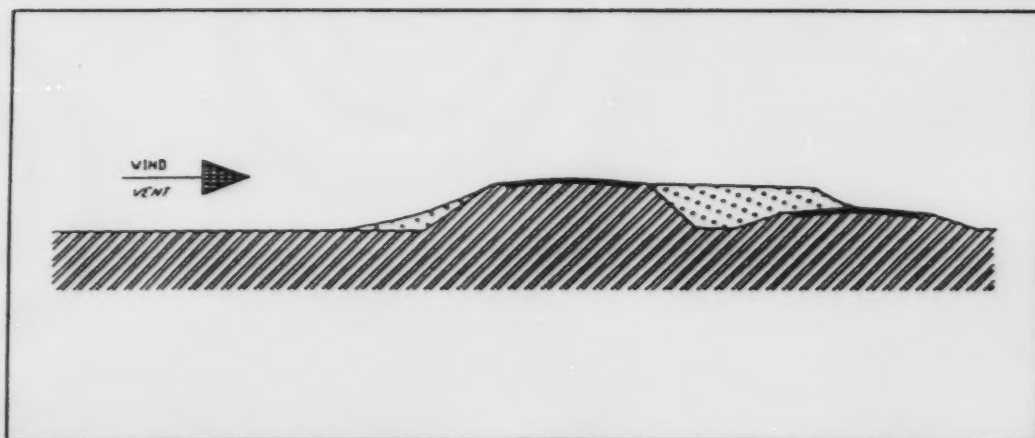
Solution - Terrace Backslopes

FIGURE 8-4

SOLUTIONS FOR PROBLEM CAUSED BY DOUBLE CUT



Problem - Snow Accumulation on Bi-Level Road Surfaces

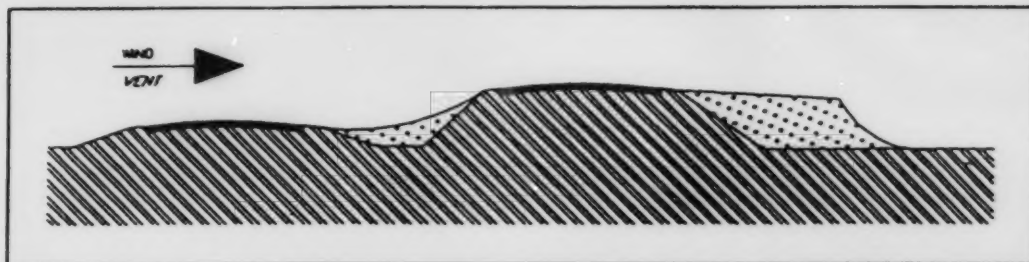


Problem Caused by Upwind Fill Section
on Bi-Level Road Surfaces

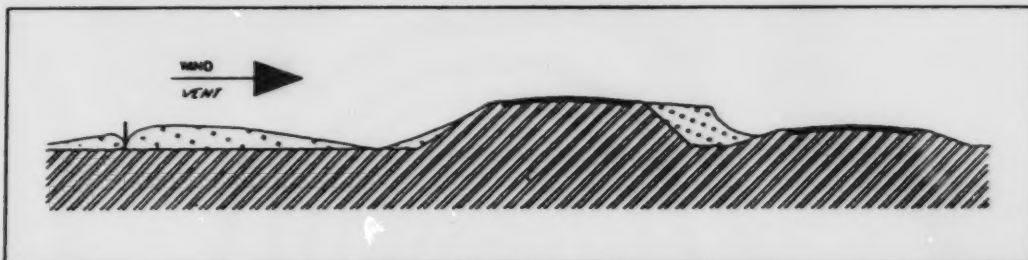
FIGURE 8-5



Solution - Add Landscaping - for details see 4-23



Solution - Elevate Downwind Road



Solution - Add Snowfence(s)



Solution - Position Roads at Same Elevation

FIGURE 8-6

SOLUTIONS TO PROBLEMS ASSOCIATED WITH
BI-LEVEL ROAD SURFACES

impact of air emissions during construction include the following:

8.2.1 Control of Fugitive Dust

Controlling fugitive dust is the single greatest variable in minimizing the impact of air emissions. If possible, operations such as clearing/grubbing/soil and borrow removal, should take place when the soils are damp. Exposed subgrade in active construction areas can result in wind erosion and these areas should be kept damp to decrease dust generation and maintain the integrity of the soil bearing capacity. The most preferable procedure would be to strip areas and place cover materials with a minimum of delay. Use of dust suppression by environmentally acceptable products other than water should be limited to special circumstances. In particularly sensitive situations or where long hauls occur, covering of haul truck loads is recommended.

Dust control during fill placement and roadbed preparation can be provided by water spray. Water application is normally necessary to maintain the materials at a moisture content optimal for placement and compaction. Dust from dumping operations can be reduced by moisture control of the materials and decreasing fall distances.

Vehicle operation during construction represents another major source of particulate entrainment. Dust control by water can be beneficial to vehicle operation as well as for material placement. Driver visibility and thus safety is facilitated by such controls and less equipment maintenance is required when dust levels are low.

Dust can be reduced by using larger vehicles and short hauls where possible, so as to reduce the required number of trips. Should sensitive locations be encountered, cleaning of vehicles which are tracking into the areas can be practiced and during periods of prolonged dry weather, soil deposits on paved surfaces can be swept and flushed clean to control re-entrainment. Reduced speed limits would be beneficial in this type of situation.

Material processing plants such as gravel or rock crushers and asphalt plants should be located well away from populated sites and should be operated in accordance with Department of Environment requirements. Dust entrainment from material storage piles in sensitive areas can be reduced by maintaining a slope of less than 10 degrees in the direction of the prevailing wind and orientation of the long dimension of the stockpile parallel to that direction. Storage piles create ten percent of suspended particulates loading on a national basis. Entrainment from storage piles depends on wind speeds, material moisture content, compaction and particle size.

8.2.2 Construction Vehicle Emissions

To avoid excess generation of emissions from construction equipment, the contractor should be required to keep equipment in good repair to prevent carry-through of elevated levels of hydrocarbons from engine operation and loss of lubricants through leakage. Refuelling should be carried out so as to minimize spillage and inlet caps maintained to reduce vaporization of fuel.

8.2.3 Mitigation Relative to Burning of Waste

Burning of waste, predominantly wood, will result in significant releases of ash, carbon dioxide, carbon monoxide and traces of toxic materials such as PAHs. These releases can be reduced by ensuring that saleable timber is removed from the right-of-way. In addition, waste wood can be hauled to wood fuelled energy facilities or chipped for mulch or compost. Where burning does occur, emissions are minimized by burning when the materials are reasonably dry while impact is reduced if the burning takes place when wind conditions are favourable. It has been found that the use of air curtain destructors which burn at higher temperatures was more economical than open burning because of the higher cost of the labour and equipment needed to tend the open fires.

8.3 Mitigation of Noise

The number of dwellings in the impact area is relatively small. Should some properties fall within the significantly impacted zone, several measures are available to

mitigate noise effects:

1. Alter right-of-way
2. Construct barriers
3. Raise or depress the roadway
4. Increase sound insulation of the properties
5. Provide compensation

Impact during construction can be controlled by regulating hours of work in the vicinity of residences or other sensitive buildings.

Any mitigative measures utilized must be properly designed and implemented. Woodlands are effective for noise reduction only after at least a 35 metre wide band of densely treed woods is present between the source and receptor.

8.4 Mitigation Relative to the Aquatic Environment

8.4.1 Soil Erosion Control

The single most important issue in protecting the aquatic environment is the control of soil erosion and sediment laden runoff. This is an area in which the design and implementation of proper mitigative measures can have a very significant effect in reducing the impact of the project, particularly during the construction phase.

In general terms each area to be stripped should be carefully examined and erosion/sediment control measures thoroughly planned before work commences. Before grubbing and stripping commences, the appropriate sediment traps and sedimentation pond(s) should be installed in accordance with the NSDOE 1988 Guidelines entitled "Erosion and Sedimentation Control Handbook for Construction Sites".

This document calls for ponds of 190 cubic metres per disturbed hectare. However, this may not adequately treat runoff containing clay size soil particles, and larger ponds, or even the use of flocculants may be required in such circumstances. The area to be cleared should be kept to a minimum and exposed for the shortest time possible prior to the application of surface stabilizing measures such as mulch, hydroseeding, rock cover and so forth.

While the greatest threat to the surrounding environment exists during construction, care should be taken to ensure that the final layout and surface treatment is sufficient to provide long term protection relative to soil erosion even under extreme runoff conditions.

8.4.2 Construction of Stream Crossings

This aspect of construction is another area where the application of careful design and construction practices can significantly mitigate environmental impacts to the environment. All stream crossings require a permit from NSDOE and this in itself provides a focus for the application of appropriate mitigative measures and controls.

In general terms, stream crossings should be constructed in summer under low flow conditions; construction equipment should not be allowed in the water course, and the design of the crossing should provide appropriate conditions in terms of velocity and water depth to allow for fish passage. In addition, culverts must be constructed such that vertical drops are absent at the discharge end and stabilized to prevent erosion from creating a vertical drop. The Nova Scotia Environmental Construction Practice Specifications (1991) describes the appropriate design details for construction of culverts and bridges. Construction of water crossings should not occur after mid-October when spawning of salmonids is likely to occur.

All major streams and rivers in the study area support valuable aquatic habitat, particularly for salmonids. Detailed construction plans should be prepared for all major

crossings and submitted to Fisheries & Oceans Canada and other regulatory agencies for review. Given the relatively small size of water crossings within the corridor, bridge design should avoid placing piers in the main low flow channel and, overall, result in minimal disruption of fish habitat. Fish passage at all water crossings, except those of intermittent streams, should be maintained at all times during construction.

The proposed alignment passes through some areas where there is currently little road access and temporary water crossings may need to be constructed for access by survey crews or other pre-construction activities. Care should be taken to ensure that any temporary water crossing structures also conform to the provincial construction practice specifications.

Fisheries & Oceans Canada has a policy of "no net loss" in fish habitat. While major impacts on the fish habitat are not anticipated, some loss of fish habitat will occur in the immediate vicinity of a crossing. For example, the short distance of a culvert does represent a "loss" of habitat. Where possible, this loss of habitat should be compensated by other stream improvements such as removal of existing fish passage barriers. Details of the appropriate compensation should be discussed with Fisheries & Oceans Canada.

8.4.2.1 Burntland Brook

To minimize impacts on aquatic habitat and its associated fen, Burntland Brook should be crossed so as to minimize the disturbance of the stream and fen. The relatively high ground on either side of this crossing should allow construction of a "bottom open" structure that will minimize impacts.

8.4.2.2 Great Village River Crossing

Construction of the crossing of the Great Village River at the proposed centreline would be difficult and a tentative design for such a crossing is not available. For this reason, as well as the issue of avoiding agricultural land, a change in route was considered as a mitigative measure. This is described in Appendix 2.

8.5 Mitigation Relative to Groundwater

The principal concern relative to the design and implementation of mitigative measures for groundwater protection is to attempt to reduce any potential impact of road salt contamination to wells near the right-of-way. This risk occurs only in winter and will likely impact only dug wells or those improperly cased. In such cases the problem is best minimized through controlled reductions in the application rate of road salt or by upgrading dug wells to properly cased deep wells.

Groundwater wells which do become impacted by road salt cannot be practically treated. Any wells contaminated by road salt would therefore have to be relocated to a less susceptible area and suitable well head protection strategies installed, or replaced with a deeper well.

8.6 Terrestrial Environment

8.6.1 Wildlife Habitat

To minimize the disruption of valuable climax hardwood stands (i.e. old and generally undisturbed stands of sugar maple, yellow birch, and beech), the alignment should be shifted about 100 metres to the west at kilometre 10 and between kilometres 13 and 14. In other areas, care should be taken to remain close to the proposed centreline of the corridor to minimize disturbance of these stands.

8.6.2 Wildlife

Construction activities in the highway corridor should be scheduled to minimize wildlife disturbance. Late October and November is a period in which several species of wildlife breed in Nova Scotia. Deer, moose and rabbits all breed during this time and are more sensitive to noise and habitat disruption during this period. April through early June is a period in which migrating birds return to Nova Scotia to nest and many species of wildlife have their young. Scheduling construction between mid-June and mid-October, if possible, would minimize wildlife disturbance. Forest clearing could occur during winter months (December - March), and could even benefit wildlife by increasing the amount of

hardwood buds at a level they can be fed on.

8.6.3 Wetlands

The disruption to wetlands can be reduced by minimizing the impact of construction on flow patterns through the bog or fen. Hydrologic impacts can be minimized by providing drainage under the highway in a number of locations, rather than concentrating all runoff into a single conduit. The depth of organic material, porosity and gradient should be determined along the final right-of-way and drainage systems designed to maintain as close to natural conditions as possible.

As mentioned under aquatic habitat, Burntland Brook and its fen should be bridged.

The alignment should be shifted 200 metres to the west to minimize the disturbance to the large treed bog west of Atkinson. Available information suggests that shifting the alignment to the west will place the alignment closer to the drainage divide, thus minimizing the impact of the highway on stream hydrology.

8.7 Mitigation Relative to Cultural Resources

The historical and cultural resources study has identified the Rushton Pioneer Cemetery (1991 NS 22-3) on Westchester Mountain as a sensitive zone. Although a complex of mid-nineteenth century to mid-twentieth century farmsteads are also found in this area they are not judged to be significant resources in contributing to the cultural history of Nova Scotia. However, it is recommended that as a pre-construction mitigation measure that these sites be marked and avoided by construction vehicles, particularly in the case of the Rushton Pioneer Cemetery.

In accordance with the Special Places Protection Act (1980), when archaeological resources are discovered accidentally in the course of development a stop

order may suspend or curtail operations until an assessment is made and necessary archaeological work or other measures are undertaken. In the event that such a situation occurs during construction of the highway, work in the vicinity of the site should be halted and contact made with the director of the Nova Scotia Museum.

8.8 Mitigation Relative to Social Impacts

Some of the potential social impacts that will result from this project can be minimized through mitigative measures. In particular, owners experiencing the loss of property use and/or value resulting from the highway could be financially compensated as well as provided with assistance in relocation. Under current legislation, owners are compensated for property required for the construction of the highway and right-of-way. Noise studies should be conducted for residences within 200 metres of the proposed roadway to determine if mitigation or compensation is required.

In addition to financial compensation for loss of property use and value, the province may be able to provide displaced households and businesses with other types of assistance in relocating once their land is required. Results from the public perception study revealed that most property owners who will be directly affected by the project prefer to remain until the highway construction actually begins.

Finally, some of the mitigation measures directed at other types of impacts (e.g. environmental, noise, land use) will address some of the impact concerns expressed by local residents, and thereby reduce the overall magnitude of personal and social disruption resulting from the project.

8.9 Mitigation Relative to Land Use

8.9.1 Agricultural Land Use

For the most part, the proposed alignment effectively minimizes disturbances to active agricultural lands. Exceptions occur in four locations identified in Figure 6-17. The

most important of these impacted areas is the one north of Great Village. As a mitigative measure, a change in the originally proposed route was considered to avoid or minimize this impact. This route change, which is proposed for adoption, is described in Appendix 2.

A large strawberry producing operation north of Glenholme and immediately downstream of the alignment is at risk of having its irrigation reservoir impacted by highway runoff. The impact may be minor because irrigation occurs primarily during the late spring and summer months, whereas large quantities of salt for deicing are used primarily in the mid-winter months. It is recommended that a first step to determine the need for mitigation measures would entail the monitoring of water quality near the intake of the irrigation pump throughout the first year of highway use.

Alternatively, a lower risk option would entail the diversion of highway runoff around the collection reservoir without eliminating the recharge source from the watershed upstream of the proposed highway.

Blueberry fields crossed by the alignment centerline (see Figure 6-17) may warrant consideration of realignment, given their reported high productivity. If realignment is not possible or deemed unwarranted, culvert underpassage should be considered at the two southern-most fields to provide access to otherwise isolated field fragments.

8.9.2 Recreation

As described in Section 7.5.2, the current and potential use patterns from recreational trails crossing the highway right-of-way should be evaluated to determine if culvert underpasses or other facilities are warranted. This should be considered in the light of concerns over increasing human access to wilderness areas versus the desirability of maintaining existing trails for snowmobilers and hikers.

8.10 Mitigation of Contingency Situations Including Hazardous Materials

8.10.1 Construction Phase Contingencies

The primary focus of contingency situations associated with the construction of the highway is likely to involve the storage and transfer of hydrocarbon fuels and lubricants. The risk of serious impact to the environment resulting from such contingencies can be reduced significantly by establishing designated refuelling and service areas that are adequately protected so that any spills and leaks are within controlled areas. Contingency plans should be in place to provide for cleanup of any spills, including the availability of adsorbants on site, as well as the appropriate firefighting equipment.

No other hazardous materials are envisaged during the construction phase other than explosives for blasting which are controlled under well established and regulated procedures.

8.10.2 Operational Phase Contingencies

Operation of the highway will involve the transportation of a very wide range of potentially hazardous materials which could be released to the environment in the event of a traffic accident. The impact such events might have is extremely hard to predict and depends on the nature of the substance involved, the location of an accident relative to environmental features, climatic conditions, and so forth. The fact that the risk of such accidents will be reduced as compared to the existing highway is an important consideration. However, further mitigation is best provided by means of having a proper emergency response plan in place. Due to the nature and geographic extent of the project, such a plan would have to involve the local communities, the two counties and the Province if it is to be a well integrated and effective effort.

PART 9
RESIDUAL IMPACTS

9.0 RESIDUAL IMPACTS

Residual impacts remaining after all mitigative measures have been applied to the project will be largely positive and reflect the economic benefits of the project described in Section 7.4.3.

There will however inevitably be some residual environmental and social impacts of a less positive, although relatively minor, nature associated with the project. For example, there will be unavoidable impacts in terms of the displacement of some residences and businesses along the alignment; disruption in use and enjoyment of properties adjacent to the alignment, and a change in the character of those largely undeveloped areas through which a highway does not currently run. For at least some of the population affected, these negative impacts will be balanced by the positive impacts anticipated, in terms of a safer highway; gaining better access to the highway system and the new business and economic opportunities such access is expected to bring. For others, the change may be regarded negatively and thus constitute a residual impact.

The greatest risk of residual impacts to the environment is associated with contingency situations during construction and operation involving major accidental spills which could impact surface and groundwaters in a currently undeveloped area. Other than applying good construction practices under the guidance of an Environmental Protection Plan (see Section 10.2), providing the safest possible conditions for the final design, and policing users of the highway, little can be done to eliminate this risk.

As described in Section 8.3.1, the control of contaminated, silt-laden runoff during construction is a major variable in terms of the potential impact of the project. To achieve adequate levels of control for the full extent of the project requires a consistent level of excellence and commitment from NSDOTC managers, designers and site supervision staff in addition to their contractors. In practice it is possible that some short term impacts to surface waters could occur during construction due to the extreme difficulty of achieving complete control on a consistent basis over the period of several years which it will take to

construct the highway.

The project will have some, albeit unknown, residual impact on wildlife in the area due to its physical presence and the increased access it will provide for human intervention. However, the area has not been identified as offering unique values relative to the rest of the Cobequids (Section 6.5.2), so this impact is judged to be minor.

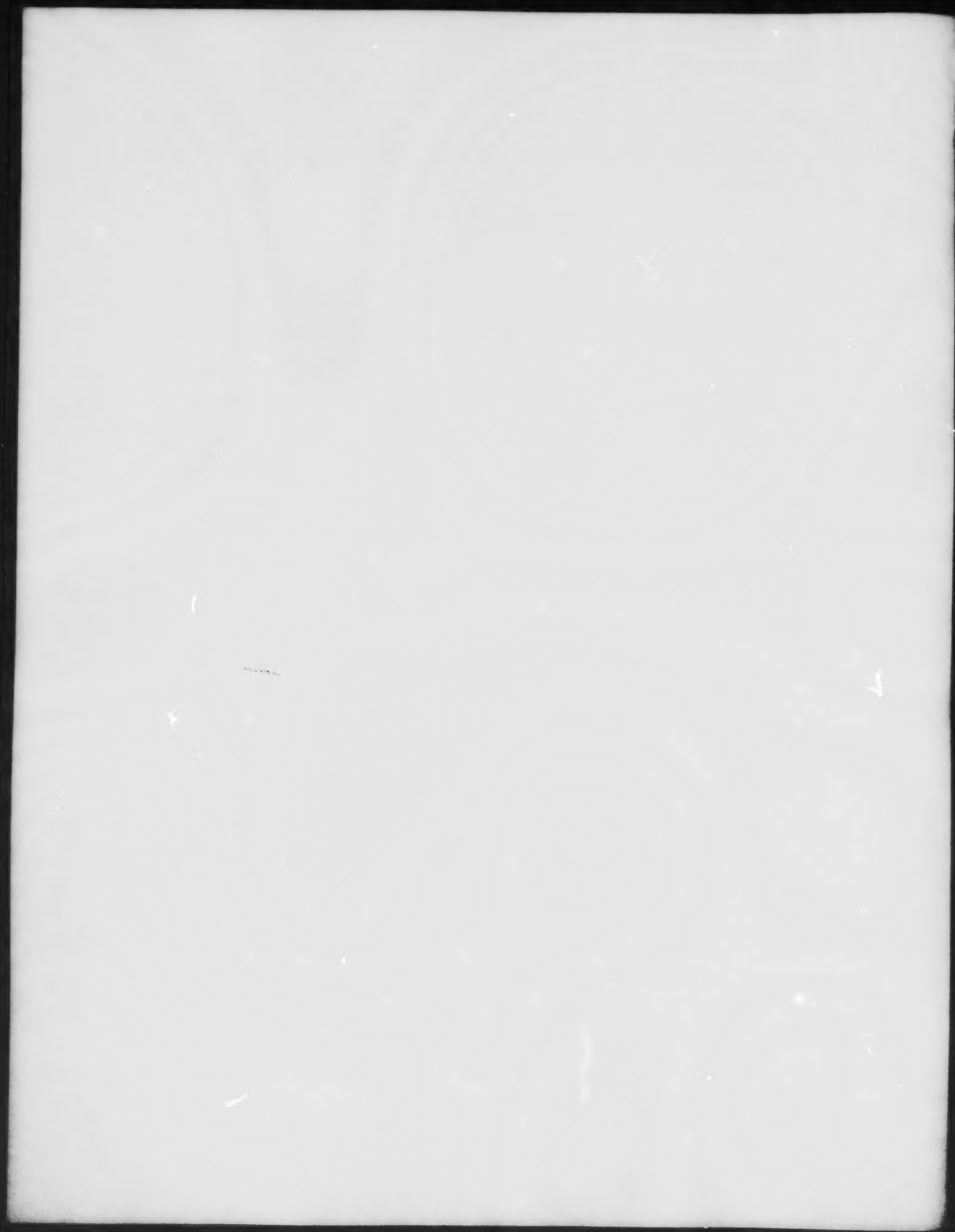
The area of blueberry barrens directly impacted is relatively small but the effect of salt spray resulting from de-icing operations is not currently known and may constitute an additional residual impact to this activity.

The project will have only a minor residual effect on the valuable climax hardwood stands in the area if the proposed alignment mitigation measures are applied. Its residual effects on the Emery Meadows wetland will likely be small but cannot be fully assessed until the methods of construction have been defined. This is due to NSDOTC being delayed in obtaining 1:5000 scale mapping and therefore being unable to provide such details at the time of the assessment.

A minor residual impact on the known heritage resources sites is possible in that they will become more accessible to the public. Experience has shown that a segment of the public will be attracted to these locations and may cause sub-surface disturbance in attempts to recover heritage objects. Routine surveillance of the highway by maintenance crews will reveal such activities. Vandalism at such locations should be reported to the director of the Nova Scotia Museum for investigation.

PART 10

PROPOSED COMPLIANCE AND EFFECTS MONITORING PROGRAM



10.0 PROPOSED COMPLIANCE AND EFFECTS MONITORING PROGRAM

10.1 Compliance Monitoring Program

A compliance monitoring program will be established by NSDOTC to ensure that all regulatory requirements and guidelines are followed along with NSDOTC internal policy matters. This program will be designed and reviewed with NSDOE and other interested agencies. It is vital that the program meet the regulatory agency requirements because it will in effect provide the day to day regulatory monitoring of the project during the construction period. It is normal for the regulatory agencies themselves to provide only an auditing function of the efficacy of the program.

Implementation of the Compliance Monitoring Program will be the overall responsibility of the NSDOTC's resident engineer but will likely to be delegated to a senior staff environmental technician or an environmental consultant in a construction supervision role.

The Compliance Monitoring Program will be developed in conjunction with a comprehensive Environmental Protection Plan addressing all aspects of the project's construction and operation.

10.2 Environmental Effects Monitoring Program (EEMP)

The EEMP differs from the Compliance Monitoring Program in that its objective is to identify environmental effects which may be long term, rather than monitoring compliance which is time specific.

NSDOTC propose to develop an EEMP on the basis of the Environmental Protection Plan with particular emphasis on ground and surface water concerns plus dust and noise levels.

10.3 Pre-Construction Monitoring

Once the specific alignment is fixed within the study corridor, a number of monitoring and survey activities will be implemented. These will include:

- a detailed survey of wells and spring water supplies potentially affected by the project (including those within an 800 metre radius of any blasting operations) involving water quality sampling and analysis and an overall assessment of the quantity available at each location
- a pre-blast survey of structures within a 800 metre radius of any areas along the highway route where blasting is planned, to include wells, building foundations, etc. which may experience damage or impact due to seismic vibration or air concussion
- a pre-construction assessment of background dust levels in the vicinity of properties likely to be impacted by construction, involving the installation of a hi-vol sampler for a representative period of time
- detailed background monitoring of noise levels in the vicinity of properties likely to be impacted by construction and/or operation of the highway.

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APPENDIX 1

EXECUTIVE SUMMARY OF INTERIM REPORT

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**ENVIRONMENTAL SCREENING OF HIGHWAY 104
TRURO TO THOMSON STATION**



**EXECUTIVE SUMMARY
OF THE
INTERIM REPORT FOR**

**Environmental Screening of Highway 104
Truro to Thomson Station
Project No. EAR-104-001**

Our File No. H91462

Submitted to:

Nova Scotia Department of Transportation and Communications
P.O. Box 186
Halifax, Nova Scotia B3J 2N2

By:

Nolan, Davis & Associates (N.S.) Limited
P.O. Box 1021, Armdale Postal Station
7020 Mumford Road
Halifax, Nova Scotia B3L 4K9

In association with:

Omnifacts Research Limited

Davis Archaeological Consultants Limited

CEF Consultants Limited

August 15, 1991

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1.0 INTRODUCTION

1.1 Background

Nolan, Davis & Associates (N.S.) Limited, in association with CEF Consultants Limited, Davis Archaeological Consultants, and Omnifacts Research Limited, were retained by the Nova Scotia Department of Transportation and Communications (NSDOT&C) to undertake Environmental Screening and Public Perception Evaluation Studies for the construction of a new controlled-access, four-lane, divided highway between Truro and Thomson Station. This document provides an executive summary of the Interim Report presented to NSDOT&C on August 15, 1991 in which the results of this phase of the work were reported.

Highway 104 constitutes one of the principal provincial highways in Nova Scotia, comprising part of the Trans Canada Highway as well as the primary road route connecting the province with the rest of mainland Canada. Since the closure of the railway in Newfoundland in 1988, the majority of freight to and from that province is by truck through Nova Scotia on Highway 104.

Because of the importance of road access, its impact on the Nova Scotia economy, and concerns over safety, there is broad public consensus across the province about the importance of upgrading the primary highways. For these reasons, the provincial government has identified Highway 104 as a top priority for upgrading to a controlled access/divided highway.

While there is consensus over the need to upgrade Highway 104, there is little agreement to date on the specific alignment this new project should follow between Truro and Thomson Station. NSDOT&C initially identified an alignment that roughly parallels the existing highway and, in September 1990, registered it, pursuant to the province's Environmental Assessment Act. Information sessions held in the area later that fall,

however, revealed clear conflicts among area residents and businesses about the desirability of the proposed route. Some interests (notably the highway-related business establishments) were keen to have the alignment near their property, while others (residents, wildlife groups and recreation-related businesses) opposed it because of concerns about the impacts of the upgrading on their lifestyle and long-term development objectives for the Wentworth Valley area.

In response to these concerns, NSDOT&C identified three additional alignments through, or around, the Wentworth Valley area (see Figure 1-1), and commissioned this study to assess the environmental and social aspects of the four alternates. The objective was to facilitate a decision as to which would offer the best overall routing when weighed in conjunction with engineering and cost considerations. Once this selection is made, a detailed environmental assessment of the preferred route will then be undertaken in accordance with the Nova Scotia Environmental Assessment Act.

The four routes considered in this study are described as:

- Western Alignment
- Registered Alignment
- Central Alignment, and
- Eastern Alignment

Each of these alternatives was identified by NSDOT&C as providing a routing on which it would be feasible to construct a 100 series highway from an engineering standpoint. No additional engineering studies were undertaken as a function of this study.

The study area was broadly defined as a 1 kilometre corridor along each of the alignments shown on Figure 1-1. The physical characteristics of each alignment are summarized in Table 1-1.

TABLE 1-1

Physical Characteristics of Proposed Alignments

Alignment	<u>Western</u>	<u>Registered</u>	<u>Central</u>	<u>Eastern</u>
Starting Community	Masstown	Masstown	Onslow	Onslow
Finishing Community	Thomson Station	Thomson Station	Mahoney's Corner	Mahoney's Corner
Total Length (km)*	58.5	63.3	55.1	64.8
Max. Altitude (m)	280	244	290	305
Elevation (m) Length (km)				
0-76	37	44	33	31
76-152	5	13	6	15
152-229	8	5	7	8
229-274	6	1	5	7
+ 274	2	0	4	4

* Distances from Truro at the Highway 102/104 Interchange to Thomson Station.

1.2 Philosophy of Approach

The approach adopted in this initial phase of the project has been to closely coordinate an overview screening of the environmental and social features associated with each route alternative, with a concurrent public perception evaluation study, while at the same time endeavouring to provide ample opportunity for public input to the process. A

period of 13 weeks was available to complete the screening and public perception aspects of the study (May 16 to August 15, 1991). A decision on the route to be assessed in detail is required by September 1, 1991, in order to provide adequate time for field evaluations before the onset of winter.

2.0 DESCRIPTION OF EXISTING ENVIRONMENT

A description of the existing environment for the study area was prepared on the basis of existing data. This section of the Interim Report is organized under the general headings of physiography, geology, climate, surface water, groundwater, terrestrial biology, aquatic biology, archaeology and land use.

In general terms, the area embraces three physiographic regions: the Cobequid Highlands Massif, the Northumberland Coastal Lowlands and the Central Lowlands. Climatic conditions and their influence on a potential highway across the highland portion of the study area is a key issue, as is the present settlement pattern in the Wentworth Valley which constitutes the present highway routing through the region.

Many of the river systems in the study area support important fishery resources, currently uninhabited areas to the east and centre of the region provide excellent deer and moose habitat, while the southern areas contain significant agricultural activity. The potential for archaeological/heritage resource sites is high in the area, particularly in the southern portions due to historical settlement and usage patterns. Significant land use issues include the Wentworth Provincial Park which would be impacted by the Registered and Central alignments and the Tatamagouche designated watershed which would be crossed by the Eastern Alignment.

3.0 EVALUATION OF PUBLIC PERCEPTIONS

This section of the study was undertaken by Omnifacts Research Limited with a view to identifying and measuring the perceptions, concerns, and preferences regarding the proposed alignments from a representative cross-section of relevant publics. The following distinct groups were included in the study:

- Residences and Businesses along the alignments
- Other properties along the alignments
- Area Residences and Business not directly on the proposed alignment
- Area Organizations and Elected Officials
- Province wide interests

The study determined that there is a very broad support for construction of a new highway and a general desire for improved safety, adequate local access and minimization of environmental impacts. Because of the variety of publics included in this study, an overall route preference could not be simply produced through a statistical calculation. However, in assessing the findings across the different publics surveyed, it was clear that a composite rank order of route preference places the Western alignment at the top of the list, being the route which, in relative terms, attracts both the most support and the least opposition.

Advocates of the **Western alignment** are most likely to be based in the Wentworth area, including owners of properties along the Registered alignment, residents of the Wentworth and Oxford area communities, as well as organizations based in the Wentworth Valley. Those favouring the Western route do so for a number of reasons, but primarily because this route is seen as having little population or communities to disrupt and, perhaps most importantly, avoids the Wentworth Valley. Organizations representing economic interests in the Debert area also favour this route because it would maintain a close link with the Debert Industrial Park. Some consider the Western alignment to be the most suitable highway corridor (e.g. most direct, lowest elevations, best weather), while

others like it because it avoids their own property along other alignments. These latter reasons, however, are mentioned by proponents of the other three alignments as well.

Those who oppose the Western alignment are most apt to either own agricultural or woodlot properties along this route (hence finding this alignment too close) or live in the New Annan/Tatamagouche area and believe this route would further isolate their North Shore communities. Overall, however, the Western route is not widely opposed by those living along this alignment, and it is the only one of the four in which alignment property owners are more likely to judge it to be suitable (52%) than unsuitable (37%) for consideration.

The **Registered alignment**, perhaps because it was the one originally proposed by the Province, is the alternative which evokes the most polarized opinions between supporters and opponents (particularly among those with direct interests in the Wentworth Valley area, through which this route passes). The Registered alignment is most likely to be the preferred route among alignment property business, commercial and agricultural interests, as well as among those living along the Central and Western routes. Proponents view this route as being desirable because they see it as the most direct and least costly; it utilizes sections of the existing highway and service infrastructure, and is likely to benefit local business.

Opposition to the Registered route is equally vocal, particularly among owners of unoccupied properties along this alignment and organizations with environmental interests. The dominant reason for rejecting this route is the anticipated impact of a new highway on the Wentworth Valley, in terms of environment and wildlife resources, tourism, and community quality of life. These concerns, however, are also shared by individuals and organizations outside of the Valley area. Another concern expressed about this alignment is that the poor weather conditions often plaguing the Valley corridor would continue to be a problem for travellers.

The **Central alignment** receives considerably less attention than the **Registered route** (with which it overlaps in the Northern section), but it attracts some of the same concerns about the potential impacts of the highway passing through the Wentworth Valley. The Central route is not strongly preferred by any identified group, while its opponents tend to be those owning property along this alignment and, to a lesser extent, those living along the Eastern and Registered alignments. Proponents of the Central route are most likely to say this alternative is the shortest, least populated and avoids their own property, while those rejecting it express concerns about its impact on the Wentworth Valley and the Debert Industrial Park (which would no longer be serviced) as well as impacts on their own property.

The **Eastern alignment** emerges overall at the bottom of the list, with almost all groups surveyed more apt to view it as a poor rather than a good route for the new highway. The one notable exception to this perspective are the residents of the New Annan/Tatamagouche area, who view the Eastern route as providing their area with improved access to the rest of the province, thereby providing a new boost to much needed economic development. However, the Eastern route is opposed by those who own property along this alignment, and it is more likely than not to be considered unsuitable by those living elsewhere in the study area, and for a variety of reasons (e.g. too long, too mountainous, loss of access to the Debert Industrial Park and Glenholme service area).

3.1 **Impacts of the New Highway**

As might be expected, most of the respondents owning property along an alignment are not happy about the prospect of a new highway passing through or near their land for obvious reasons (loss of property or reduced enjoyment of it, increased noise, traffic, etc.). Moreover, property owners are more likely than not to anticipate that the value of their property will decrease significantly once the highway is built, and to experience a great deal of difficulty should they decide (or be forced) to relocate. Those most likely to express a negative response to a potential highway nearby are those with properties on or adjacent

to the alignment (as opposed to those within 500 metres), owners of agricultural properties and long time residents of the area (40 plus years).

Owners of business and commercial properties, however, are more divided about the prospect of a new highway, and as many expect it to benefit as to harm their operations. About half of the businesses located along the alignments anticipate the need to relocate if the new highway does pass through, but most say this could be accomplished without putting them out of business.

How people expect a new highway to affect their own local area community appears to depend in large part on whether or not they are located along one of the alignments. Alignment property owners generally believe the highway would have negative impacts on their local community as well as on their own property. These residents and businesses expect the highway would result in the loss of property, residents and local businesses, change the character of their community and harm both environmental and agricultural resources.

Study area residents and businesses not situated immediately along the alignments, however, express a very different perspective, being much more likely to see the highway as benefitting their local community, in terms of providing a safer, more accessible highway, boosting the local economy and jobs, and promoting tourism. Few expect the highway to have a positive effect on the local environment or agriculture, but fewer still believe there would be a negative impact on these resources.

The generally positive response to the screening process notwithstanding, criticisms and dissatisfactions were expressed as well, the most widespread being a concern about the potential for political interference to influence or overturn the selection of a route based on the technical evaluation. Interest in this project runs strong throughout the area (indeed, 90 percent or more from every group surveyed say they want to be kept informed as the project proceeds) and the public undoubtedly will be paying close attention to the

final selection decision. The public's response to this decision is likely hinge as much on its perceptions of the process that was used to reach it as on the choice of route ultimately selected.

4.0 ROUTE SCREENING PROCESS

4.1 Methodology

The approach used to provide a comparative screening of the four route alternatives was based on the application of a well established and tested procedure designed to enable the public and regulatory officials to provide input to the selection process in a constructive manner rather than to merely act as critics after the selection is made.

Two integrated approaches were used: the first involved the development of listings of "advantages and disadvantages" for each route alternative based on the findings of the study team, and perhaps more importantly, from the input of the public and selected interest groups. The second involved a numerical ranking methodology which has been used for numerous multi-disciplinary site and route selection studies in Canada and elsewhere. It is based on scoring (as compared to ranking) each of the alternatives for an agreed list of parameters. In this case, the list of parameters included the 20 environmental criteria shown in Figure 4-1.

Interactions of little or no impact are scored 0, high negative impacts are scored 5. The methodology allows for varying degrees of sophistication in the application of these scores. They can be simply added so that the option with the least score represents the least impact, or each parameter can be weighted and the scores multiplied by the weighting before addition. Doing both allows the sensitivity of the weighting to be easily seen.

An important element in the route screening process was a "consultative workshop", consisting of representatives of various public interest groups from the study area, members of the study team and representatives from NSDOT&C. At this meeting which was held in Wentworth on July 17, 1991, draft listings of the advantages and disadvantages associated with each route were reviewed and modified to reflect the input of the group. The final versions of these listings, reflecting this input are provided in Tables 4-1 to 4-4.

4.1.1 Parameter Weighting

As previously described, the screening matrix can be used with or without weighting factors applied to the respective route alternative parameter scores. Use of weighting factors can have a major influence on the outcome of the process as it tends to accentuate relative differences between the alternatives.

High weightings were given to Fuel Consumption (5), as the parameter most influencing long-term energy usage, emissions, and other generic highway impacts; to Weather Conditions (4), as the environmental parameter most influencing safety; to Rare and Endangered Species (4), due to their potential to solely influence route selection; and to Residential (4), as the parameter most reflecting direct impacts on people.

Figure 4-1

Numerical Screening Matrix

Environmental Parameter	Parameter Weighting 0 to 5	Registered Alignment		Western Alignment		Central Alignment		Eastern Alignment	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Fuel consumption	5	2	10	1	5	0	0	3	15
Proximity to water supplies.	3	4	12	1	3	3	9	5	15
Proximity to archaeological sites	3	3	9	4	12	2	6	1	3
Hydrology/hydrogeology	2	4	8	2	4	3	6	3	6
Weather conditions	4	1	4	2	8	1	4	3	12
Rare and endangered species	4	3	12	2	8	4	16	3	12
River crossings/fish habitat	2	3	6	2	4	3	6	4	8
Wetland habitat	2	3	6	4	8	3	6	2	2
Wildlife	2	2	4	1	2	3	6	2	2
Geology/acid generation	1	2	2	1	1	3	3	2	2
Erodible soils/soil failure	1	3	3	1	1	2	2	4	4
Parks and reserved lands	1	3	3	1	1	2	2	3	3
Cemeteries	2	1	2	0	0	3	3	0	0
Utilities	1	1	1	1	1	1	1	1	1
Noise and dust levels	2	4	8	1	2	1	2	1	2
Agriculture (existing and potential)	3	2	6	3	9	3	6	2	2
Recreation	3	5	15	1	3	4	12	3	9
Residential	4	5	20	1	4	4	16	2	8
Existing commercial	1	1	1	3	3	2	2	3	3
Development potential	3	4	12	1	3	4	12	0	0
Totals -unweighted		56	XXX	33	XXX	49	XXX	46	XXX
Totals-weighted		XXX	144	XXX	83	XXX	120	XXX	118
Rank		4	4	1	1	3	3	2	2

Notes:

Score: 0 - no impact; 5 - high impact.

Weight: 0 - no importance; 5 - high relative importance.

Lowest total is preferred environmental option.

Table 4-1

List of Advantages and Disadvantages
Western Alignment

<u>Advantages</u>	<u>Disadvantages</u>
• low population density • low number of water supply wells • maintains good access to Debert Industrial Park • good scenic potential (tourism) • low potential for acid drainage sites (no known sites) • mostly small stream crossings • least impact on recreational resources • low impact on deer and moose • second shortest route • least limited for future expansion • enhances access to West Colchester shore	• cannot construct in phases • does not enhance access to North Shore area • impacts most agricultural lands at south end and blueberry barrens further north • potential weather problems on high ground • highest number of known heritage sites • potential for some noise impact at Sutherlands Lake cottage area • north end could have potential for rare species and impact on furbearers and wetland habitat

Table 4-2

**List of Advantages and Disadvantages
Registered Alignment**

<u>Advantages</u>	<u>Disadvantages</u>
• largely avoids steep grades and elevations • least number of stream crossings • best maintains existing business base • least disruptive to wildlife • maintains good access to Debert Industrial Park • can be constructed in phases • relatively low impact to agriculture • enhances access to West Colchester shore	• opposed by Wentworth Valley residents and Folly Lake cottagers • incompatible with tourism/recreational development objectives for the Valley • potentially high impact to Folly Lake area (cottagers and ecology) • highest negative impact on property values • highest sociological impact • impacts proposed ecological reserve • crosses Wentworth Provincial Park • four potential acid drainage sites identified • greatest number of water supply wells • impacts recreational resources • highest number of significant heritage sites • potential impact on Wallace River • poor future expansion potential • impacts Folly Lake Quarry

Table 4-3
List of Advantages and Disadvantages
Central Alignment

<u>Advantages</u>	<u>Disadvantages</u>
• shortest, most direct route • little population on south end • good access at Truro • can be constructed in phases	• opposed by Wentworth Valley residents • highest length of +900 ft. elevations (potential weather problems) • highest number of large river crossings and total number of crossings • four potential acid drainage sites • downgrades access to Debert Industrial Park • second largest number of heritage sites and closest to known Paleo-Indian sites • crosses Wentworth Provincial Park • impacts recreational resources • impacts some agricultural land at southern end • potential impact to Wallace River • impacts proposed ecological reserve • impacts good deer and moose habitat • impacts good waterfowl habitat • impacts existing businesses at south end and in Valley

Table 4-4

List of Advantages and Disadvantages
Eastern Alignment

<u>Advantages</u>	<u>Disadvantages</u>
• avoids population • improved access to North Shore and Tatamagouche • avoids most of Wentworth Valley • least number of known heritage resources • few large river crossings and less salmon habitat • potential scenic route • low number of water supply wells impacted • provides potential future link to New Glasgow • good access at Truro	• longest route • highest elevations (fuel, climate etc.) • impacts good deer and moose habitat • downgrades access to Debert Industrial Park • existing highway business eliminated • uranium mineralization nearby • two potential acid drainage sites • passes through the Tatamagouche water supply watershed • impacts recreational and cottage country near Byers Lake Warwick Mountain • impacts some agricultural land • potential construction/operation impacts to Byers Brook • cannot construct in phases • future expansion at north end may be limited • impacts Wentworth Centre

4.2 COST AND CONSTRUCTION CONSIDERATIONS

4.2.1. Cost Comparisons

Table 4-5 presents the results of a present value analysis for the cost of operating vehicles on the four alternate routes. A twenty-five year period, 1995 to 2019 inclusive, was used for the analysis. Recent traffic information (5140 cars and 1450 trucks, perday in 1989) was adjusted for one percent growth per year. Operational costs were assumed to be \$1.00 per km for trucks and \$0.30 for cars. These figures were escalated at 5 percent per year. Fuel consumption data was based on average consumption rates of 43.7 litres per 100 km for trucks and 9.7 litres per 100 km for cars.

The analysis reflects the length of each route, with the shortest routes showing the least cost. The present value of operating costs for the most expensive route (Eastern) is approximately 18 percent greater than that for the least expensive (Central). The difference represents \$229 million over the 25 year period.

TABLE 4-5
Operational Costs and Fuel Savings

Route	Construction Cost \$ million	Present Value of Operation Costs (Est. 1995-2019) \$ million	Total Cost \$ million	Fuel Consumption (Est. 1995-2019) litres
Eastern	121	1,527	1,648	803,000,000
Central	111	1,298	1,409	683,000,000
Registered	123	1,478	1,603	777,000,000
Western	113	1,374	1,487	722,000,000

Note: Construction cost data provided by NSDOT & C

As fuel consumption varies directly with mileage, fuel usage is also about 18 percent greater for the Eastern route versus the Central route. The difference of some 120,000,000 litres of fuel represents a significant reduction in resource usage and air emissions generated.

4.2.2 Cost vs. Environmental Ranking

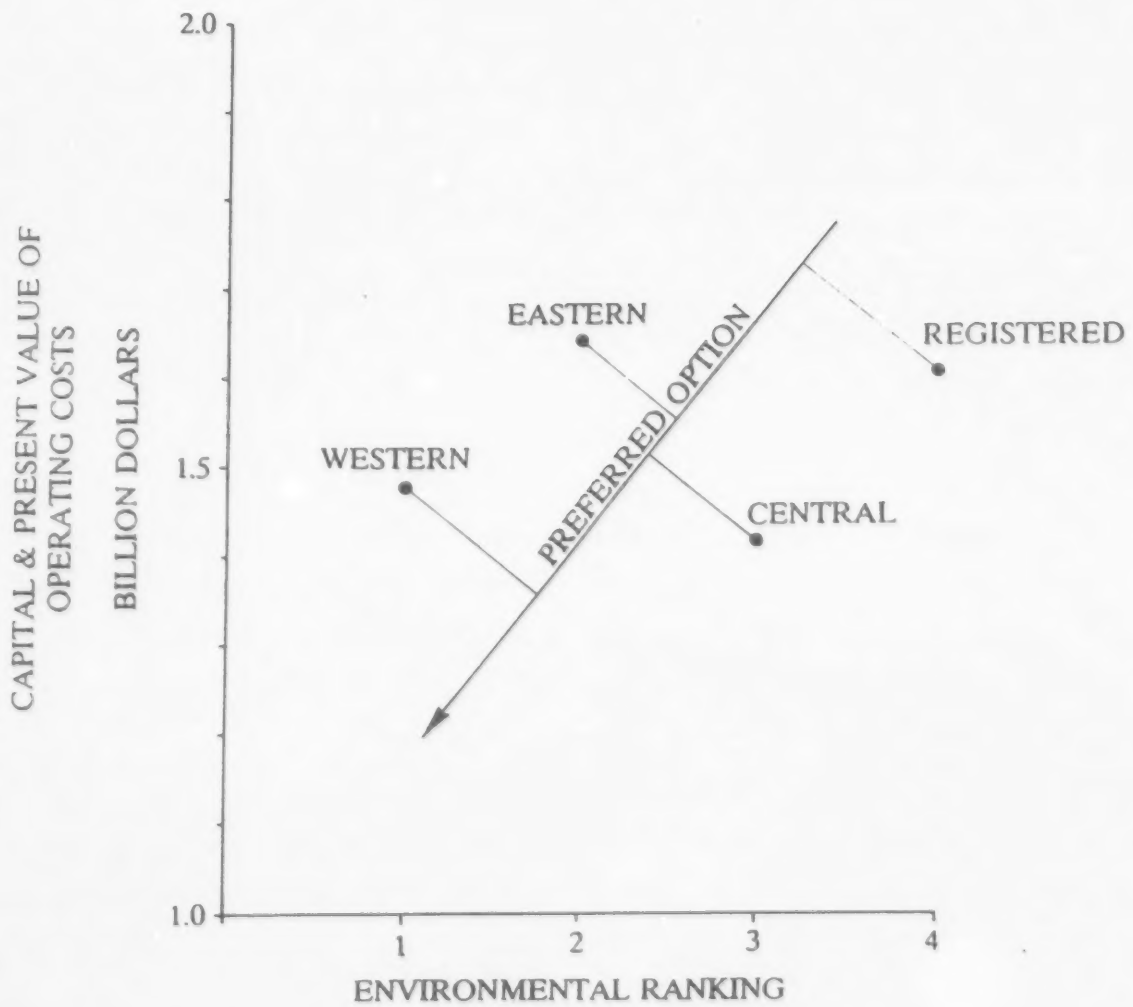
The figures derived in Table 4-5 are plotted against environmental ranking in Figure 4-2. A total of the estimated capital construction cost and the present value of operating costs over a 25 year period was used. It is notable that the operating costs are an order of magnitude greater than the capital costs when expressed in this fashion.

The diagram presented as Figure 4-2 helps in making a judgement between tangible cost considerations and non-quantifiable environmental/social factors. It does not, however eliminate the need for judgement. In this case, it merely highlights the fact that the Western option, as the second least expensive alternative, offers environmental and social advantages which will cost approximately \$2 million more in capital expenditures, or \$76 million more in amortized operating costs over 25 years, when compared to the least cost option, namely the Central Alignment.

4.2.3 Construction Phasing

The advantages of a new 100 series highway will be realized sooner if construction can be phased in segments along the section under consideration. This would also likely provide financing benefits and public exposure to the fact that construction is ongoing.

Detailed consideration of phasing opportunities is outside the scope of this study, but in general terms, the Eastern Alignment provides virtually no such opportunities; the Registered Alignment provides the most flexibility, followed closely by the Central Alignment. The Western Alignment would have to be completed between Thomson Station



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FIGURE 4-2
COST VS ENVIRONMENTAL RANKING CHART
HWY. 104 ENVIRONMENTAL ASSESSMENT
TRURO TO THOMPSON STATION, N.S.

and Glenholme before it could be used, but construction of the highway between Truro and Glenholme could be started immediately following the Environmental Assessment Study.

5.0 CONCLUSIONS

Selection of a route for a 100 series highway between Truro and Thomson Station is difficult due to the constraints inherent in the topography and associated winter weather conditions as well as established land-use, residential and commercial patterns. None of the four route alternatives is without potentially negative impacts, and conversely, all have some positive attributes. Selection of the preferred route is therefore a judgement call which should be based on consideration of the environmental screening and public perception data presented in this report along with engineering, cost, scheduling and long-term planning considerations outside the scope of this document.

Notwithstanding the above statement, the Western Alignment clearly ranks as a preferred route from the environmental/social standpoint based on the methodology applied and judgements made relative to the scoring and weighting of the parameters used (refer Table 5-1). The public perception component of the study supports this finding and suggests that the Western route is regarded positively because it avoids the Wentworth Valley, maintains the close link to the Debert Industrial Park, and provides a "suitable" highway corridor in terms of distance and weather conditions. It is however opposed by interests in on the North Shore who least favour this alternative because of the lost opportunity for improved access to that region.

TABLE 5-1
Summary of Environmental Screening Results

Route	Weighted Score ^a	Ranking
Western	83	first
Eastern	118	second
Central	120	third
Registered	144	fourth

^a Refer to Figure 4-1 for details

The Western Alignment is the second shortest of the four alternatives (58.5 km as compared to 55.1 km for the Central Alignment). It is estimated to cost approximately \$113 million to construct which is \$2 million more than the Central Alignment and will incur greater long-term vehicle operating costs proportional to its length.

The diagram presented as Figure 4-2 in the foregoing section identifies relationships between environmental ranking and capital cost plus present value of operational costs for the four alternatives. Again the Western Alignment appears to be attractive in this regard, although it is longer and thus more costly than the Central Alignment.

The Eastern Alignment is the only route for which there are strong advocates, namely the residents of the North Shore region of the Province. The environmental scoring of the route would be greatly improved if the alignment in the Warrick Mountain area could be redirected through the East Swan Brook gully. This would shorten its length by approximately 7 km, avoid the Tatamagouche designated watershed, as well as impacts to cottages in the Byers Lake area. A preliminary engineering assessment of this route alternative by NSDOT & C however, was not favourable.

APPENDIX 2

**Environmental Assessment of Route Change
Near Great Village**

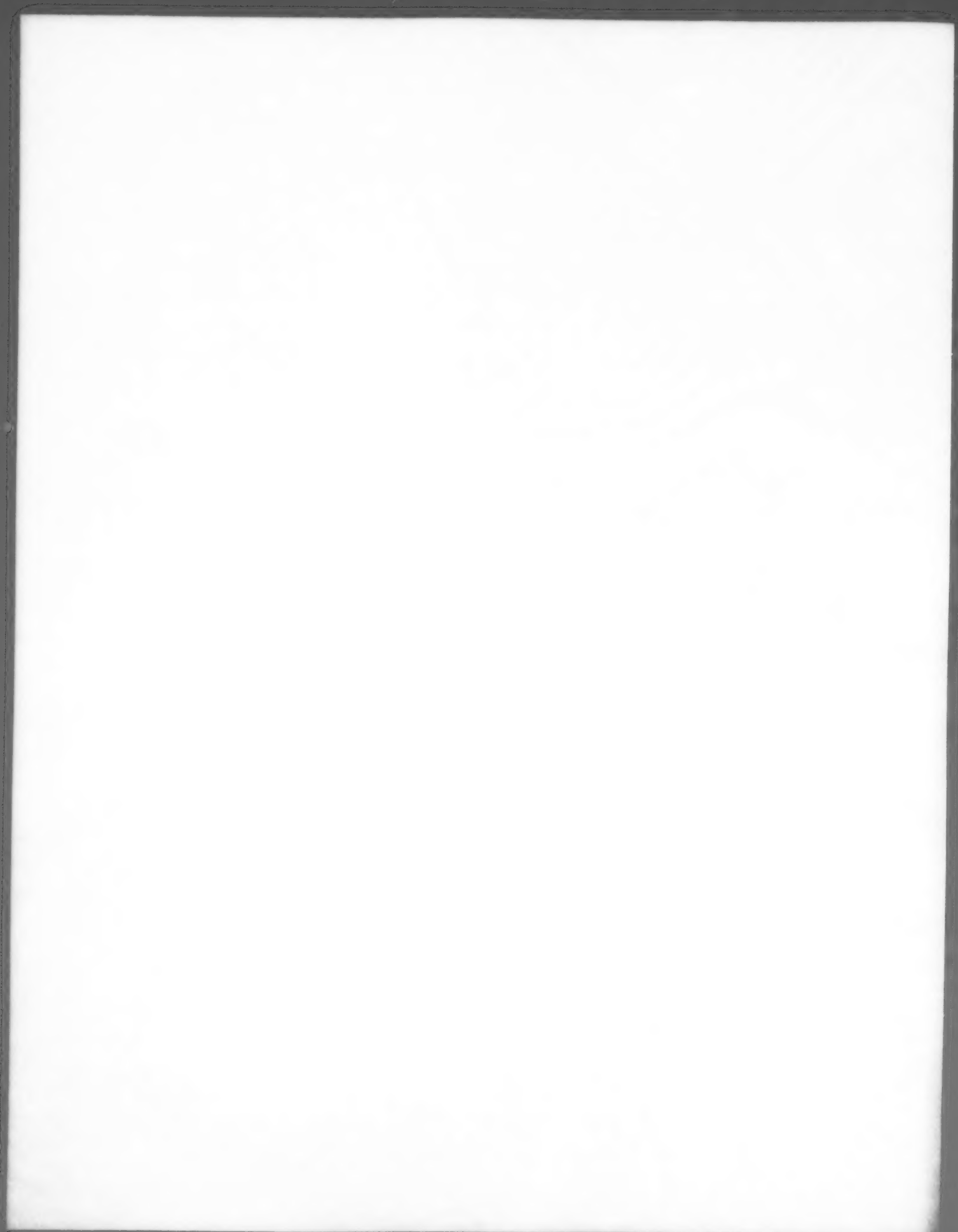


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1.0 INTRODUCTION

Parts Seven and Eight of the main report identify a potential concern with the proposed highway alignment in the area north of Great Village on the basis of its impact on Class 2 agricultural land and concerns over the Great Village River crossing. As a mitigative measure it was decided by NSDOTC to investigate an alteration of the proposed route to a new and more easterly alignment over a 6.7 kilometre distance. The proposed change in alignment is shown in Figure A2-1.

As a function of assessing this proposed mitigative measure, it was recognized that a detailed Environmental Assessment would be necessary to provide consistency with the rest of the alignment since the changes are outside of the original study area. Accordingly, the additional field work required to provide a consistent level of assessment was conducted in late April 1992. This appendix provides the incremental Environmental Assessment information required to complete the overall route assessment.

2.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

A detailed description of the existing environment is included in the body of the main report. For the purposes of this assessment only those components which are directly affected by the alteration of the initial alignment are discussed.

2.1 Geology

2.1.1 Bedrock Geology

The proposed route change passes over bedrock primarily of the Late Triassic age Wolfville Formation. A short section of this route (near kilometre 31 + 000) is situated in an area mapped as the Late Carboniferous Parrsborro Formation bedrock (Donahoe and Wallace, 1982).

Bedrock outcrops of the Wolfville Formation were noted at several localities along Great Village River and Moose Brook during the site reconnaissance (Figure A2-2).

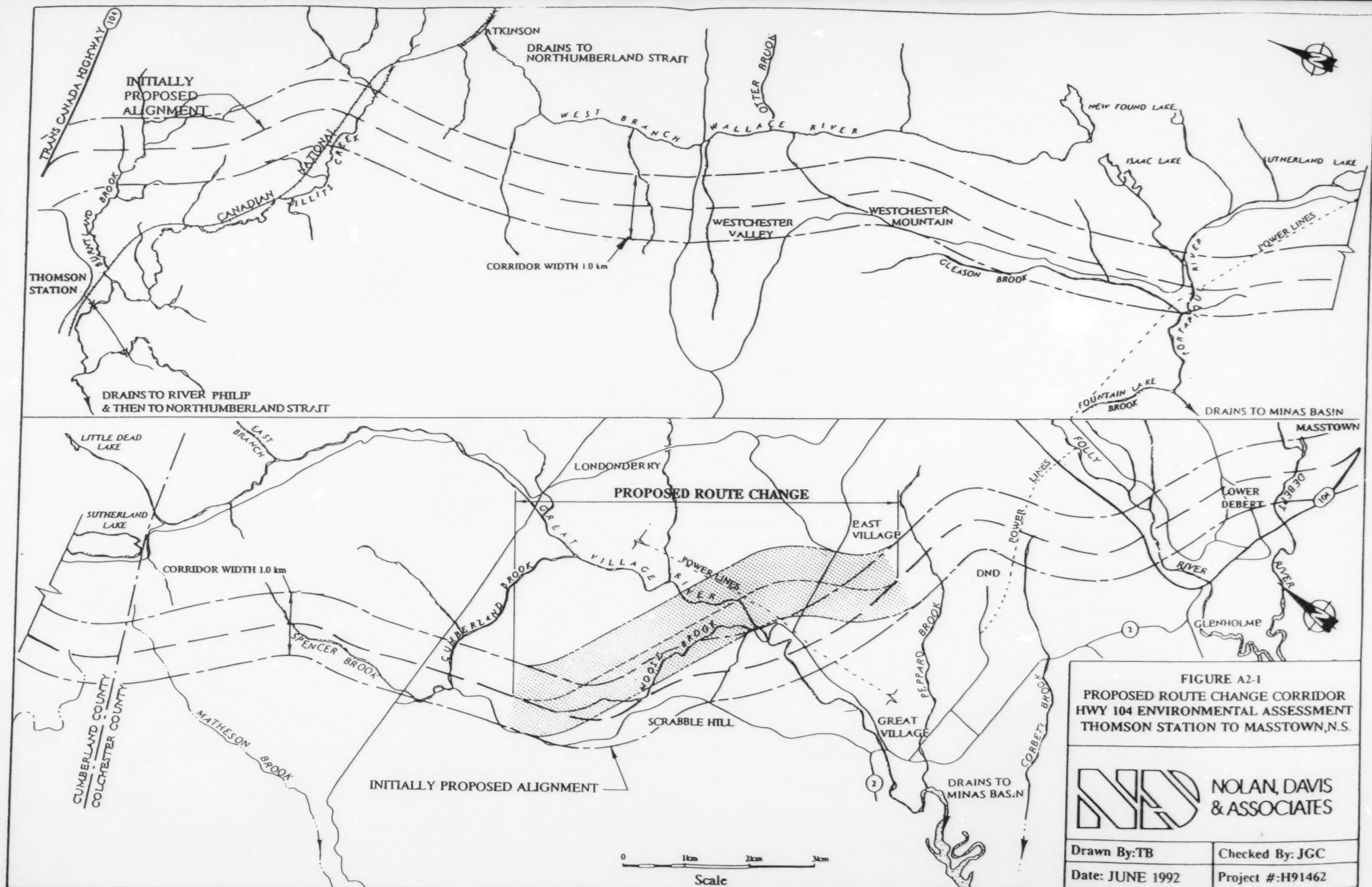


FIGURE A2-1
PROPOSED ROUTE CHANGE CORRIDOR
HWY 104 ENVIRONMENTAL ASSESSMENT
THOMSON STATION TO MASSTOWN, N.S.



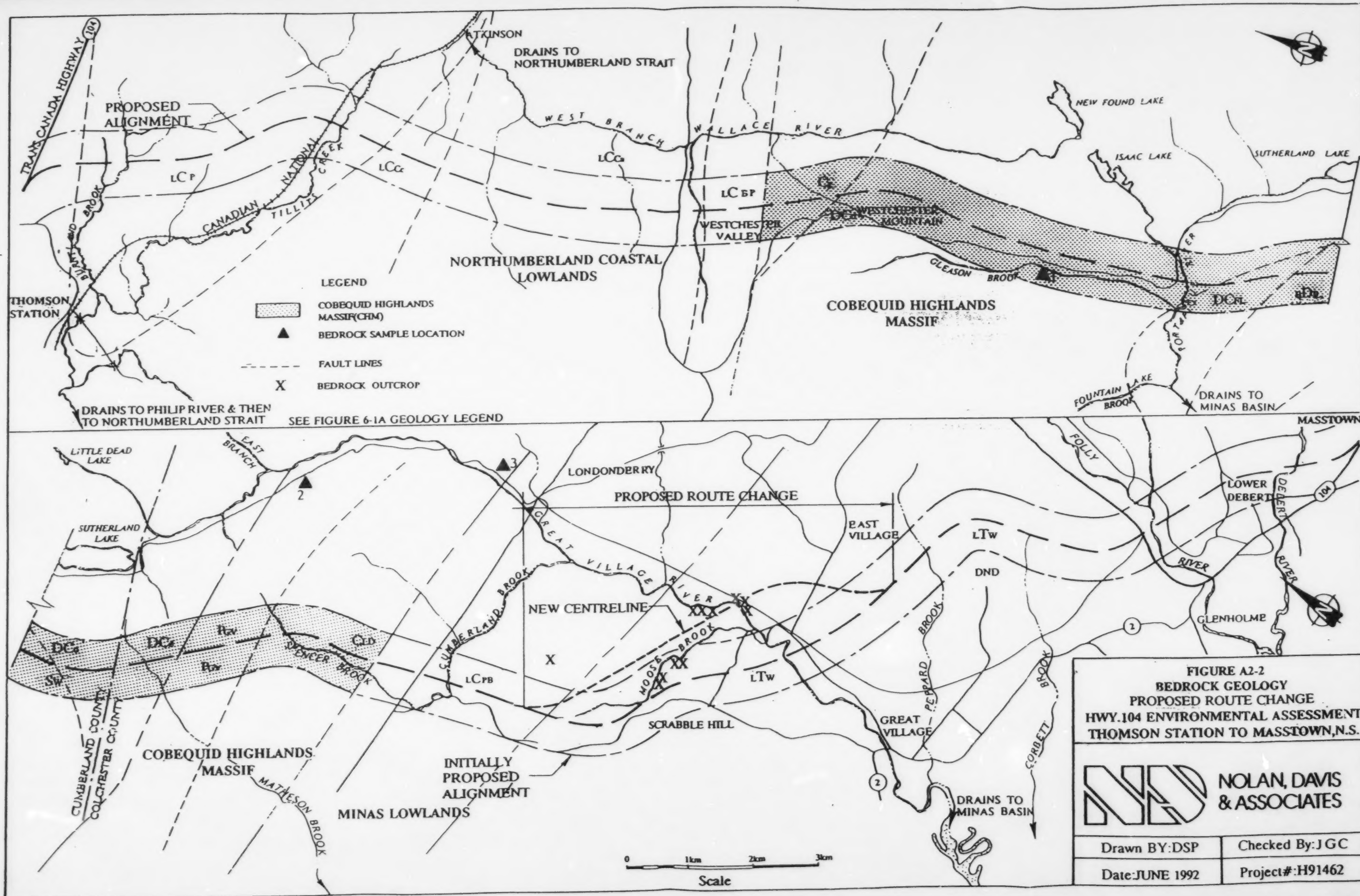
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Drawn By: TB

Checked By: JGC

Date: JUNE 1992

Project #: H91462





The major rock types noted in the river and brook traverses consisted mainly of conglomerate, with minor sandstone and siltstone. These findings concur with existing mapping by Donahoe and Wallace (1982). Although outside of the proposed corridor alignment, one outcrop of the Parrsboro Formation, identified as siltstone, was noted along a logging road.

There was no evidence of sulphide mineralization in the collected bedrock samples which were field examined by a geologist. Discussions with Department of Natural Resources geologists also indicate that the likelihood of the Wolfville or Parrsboro Formations producing acid drainage is minimal.

2.1.2 Surficial Geology

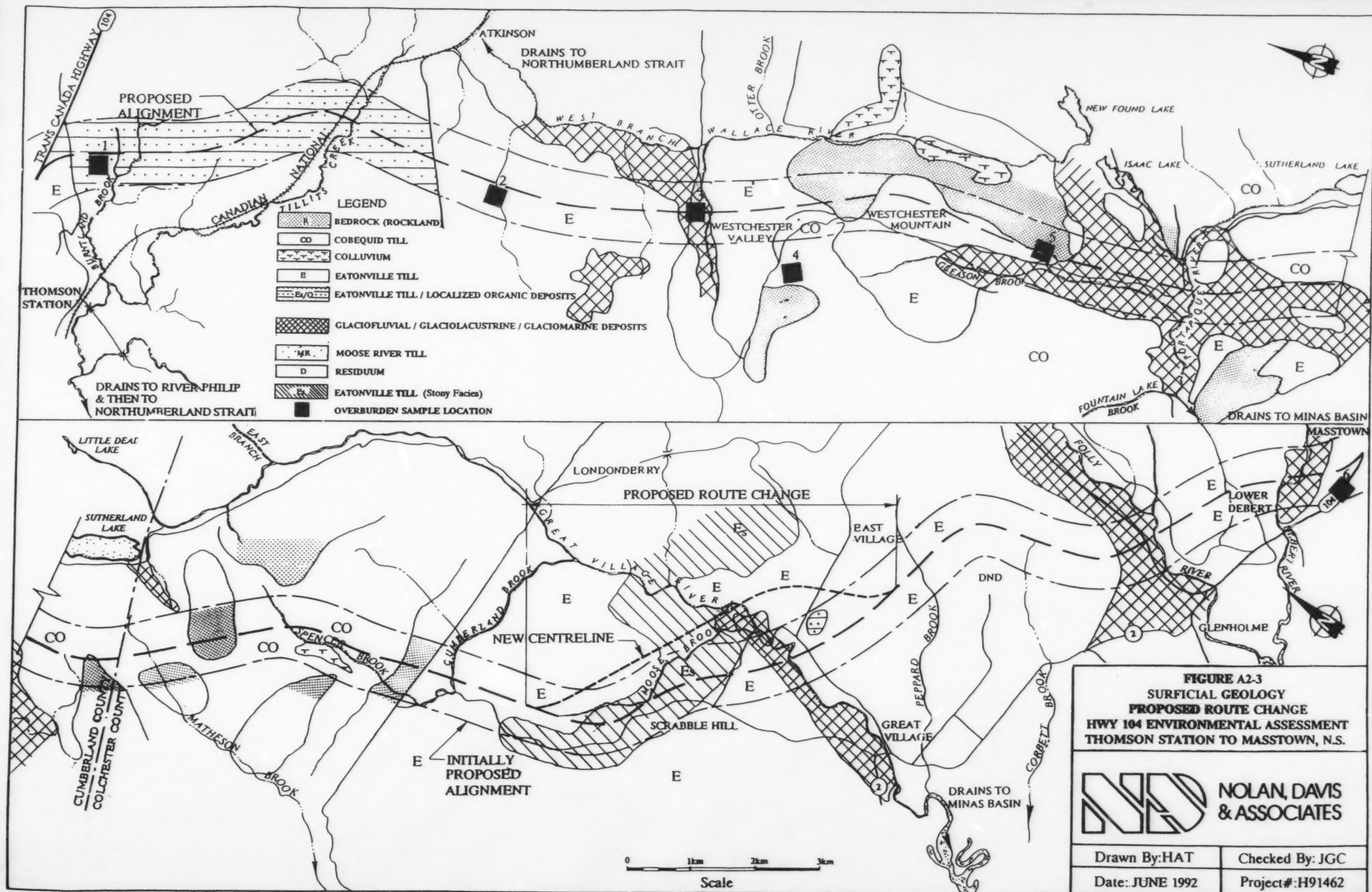
The predominant surficial material noted in the proposed route change study area is till. The Eatonville Till and a stony, sandy faces of this unit occur in all areas along the proposed new alignment except for a small lens of alluvial deposits which are located on the west side of the Great Village River at approximately kilometre 34+350 (Figure A2-3). An estimate of the maximum till thickness in the study area is about six to eight metres based on observations. There was no evidence of exploitation of the till or alluvial deposits for borrow material in the study area.

2.2 Air Quality

Existing air quality along the proposed route change is considered to be identical to that for the original Western Alignment. Similarly, climatic and weather conditions for this section of roadway, on the southern approach to the escarpment for the Cobequid Mountains, is expected to be the same.

2.3 Sound Levels

As for other portions of the original alignment, sound levels depend on transportation routes and adjacent land use. Figure A2-4 provides the results for sound level tests taken where the proposed route change crosses Station Road at location 11. As for



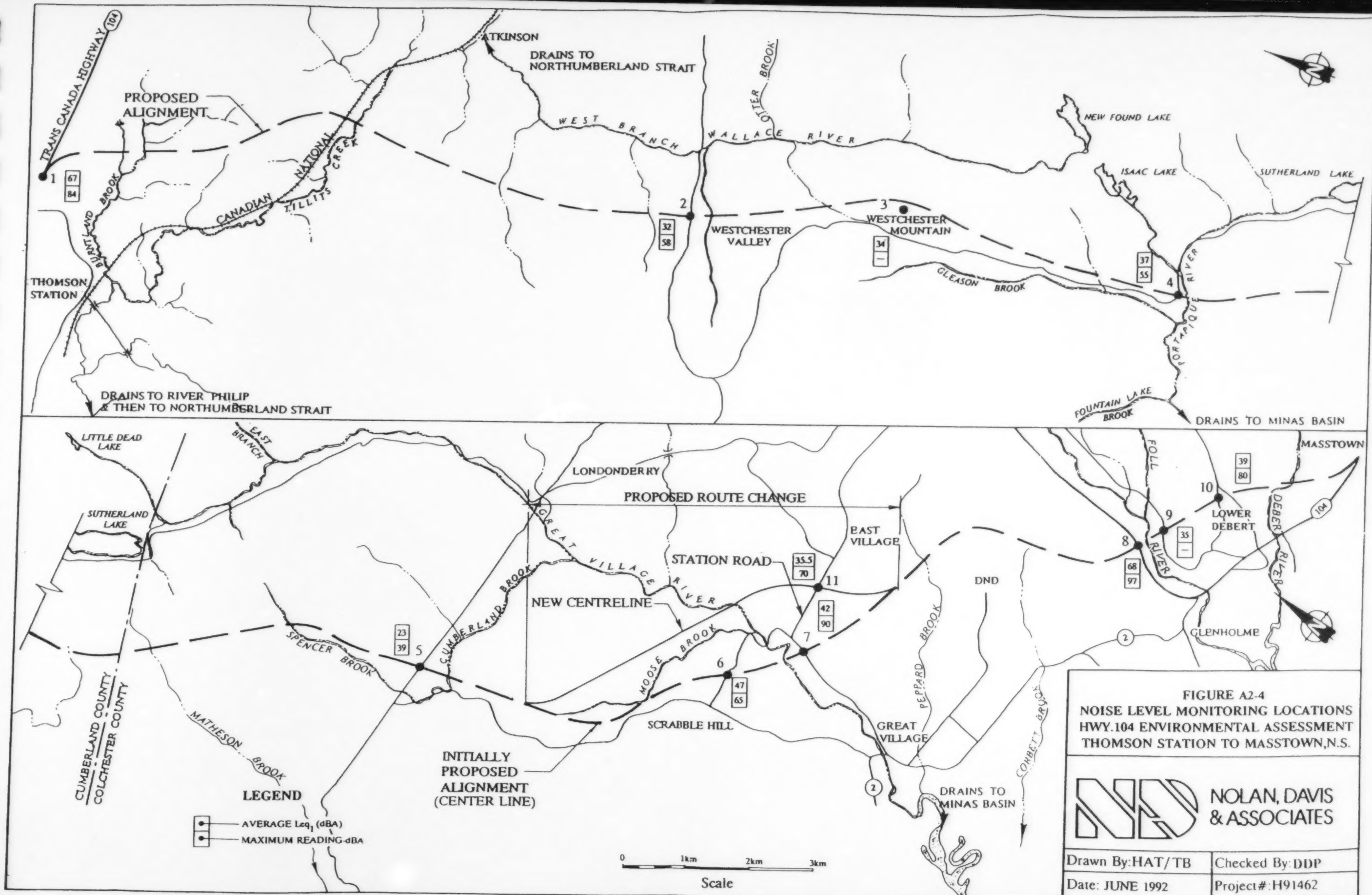
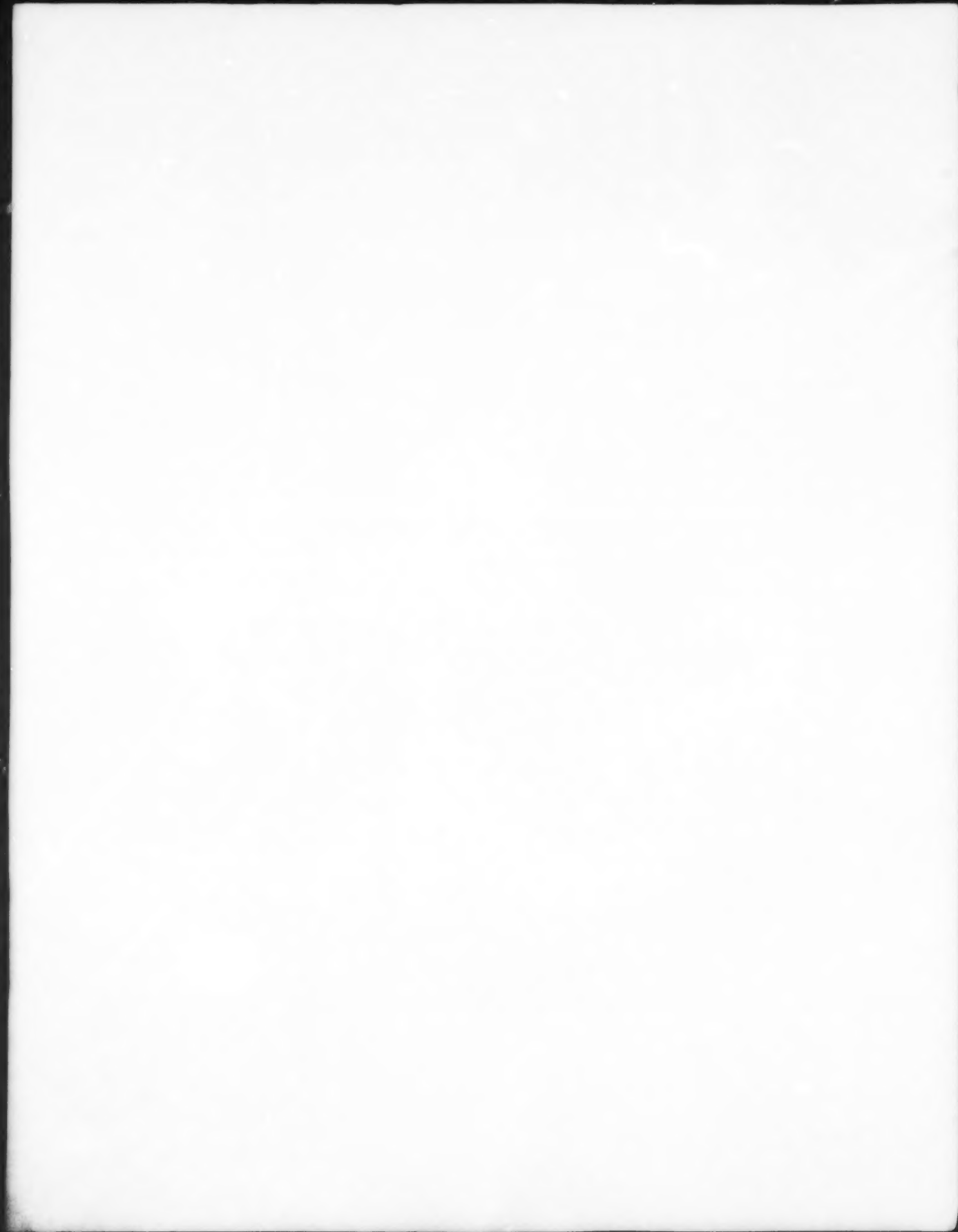


FIGURE A2-4
NOISE LEVEL MONITORING LOCATIONS
HWY. 104 ENVIRONMENTAL ASSESSMENT
THOMSON STATION TO MASSTOWN, N.S.

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Drawn By: HAT/TB	Checked By: DDP
Date: JUNE 1992	Project #: H91462



location 7, sound levels are highly dependent on traffic levels on Station Road. Sound levels at a location eight metres from the center line of Station Road were found to vary from 28 to 70 dBA, with maximums due to light vehicle traffic. L_{eq} for this location was 35.5 dBA. Typical sound sources were motor vehicles, birds, distant traffic and equipment noise.

2.4 Aquatic Environment

As in the main study, water crossings are defined by the centerline of the alignment crossing a water course shown on 1:50,000 scale National Topographic Series maps. Electrofishing was not conducted at the crossing of the new alignment because of its proximity to the original alignment. However, fish habitat was mapped by walking the stream 500 metres upstream and downstream of the proposed centerline.

2.4.1 Route Comparison

The new alignment crosses the Great Village River just over 1.1 kilometres further north. This shift eliminates the crossing of Moose Brook (Crossing 13) and does not cross any additional streams (Table A2-1).

TABLE A2-1

Characteristics of Water Crossings for Proposed Route Change

Watershed	River	Number	Crossing at Centreline of Alignment				Stream Gradient*
			Stream Velocity (m/s)	Stream Width (m)	Water Depth (m)	Stream Flow	
Great Village River	Moose Brook	13	crosses only small intermittent side drainage				
Great Village River	Main Channel	14	1.14	20.0	0.5	moderate	0.005

Note: *gradient at the actual crossing, based on contours on 1:10,000 orthophoto mapping.

2.4.2 Water Crossings

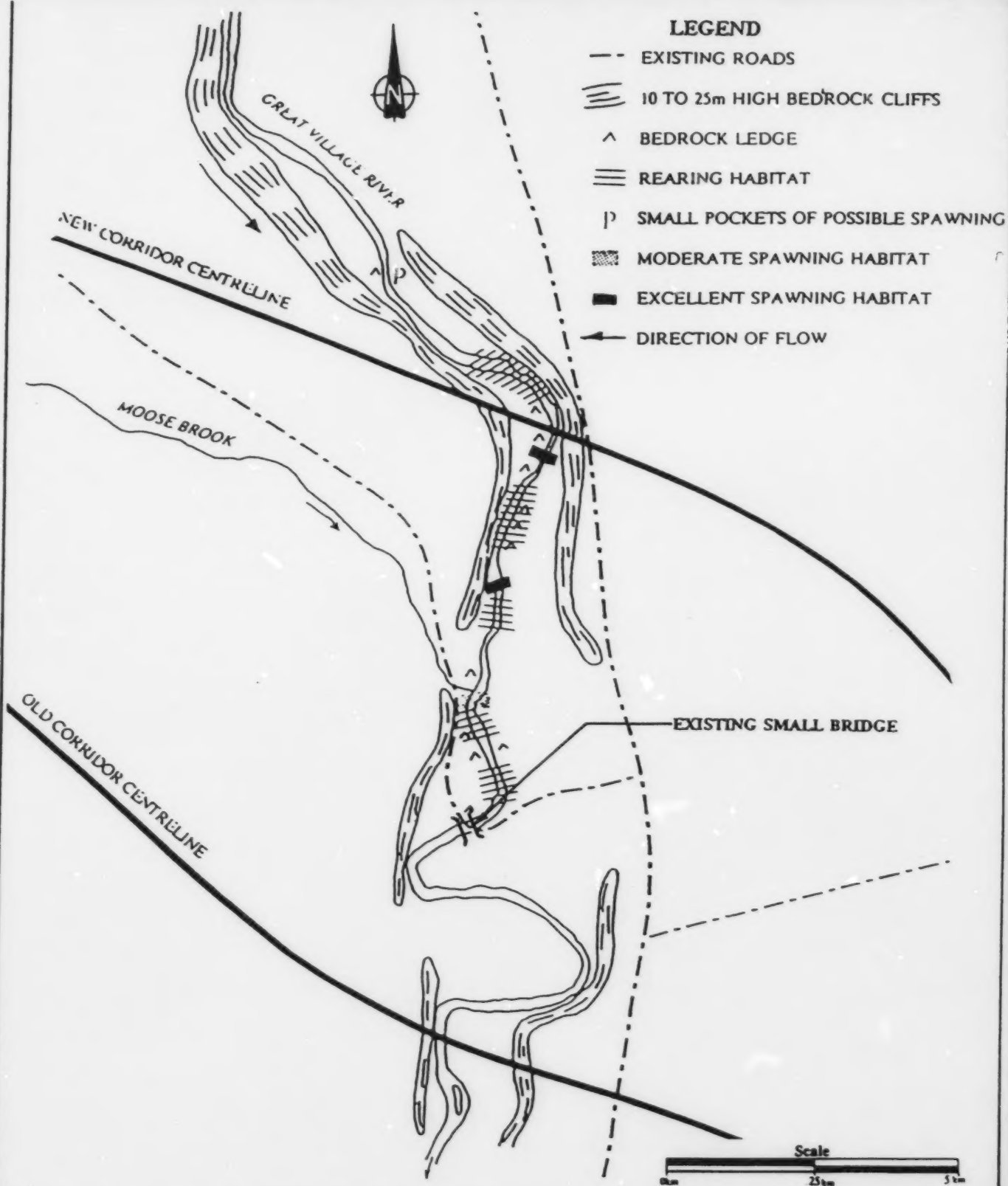
The crossing of the Great Village River is the only main water crossing within the 6.7 kilometres of the new alignment. The characteristics of the crossing at the proposed centerline are provided in Table A2-1 and a description of the fish habitat within the corridor is provided in Table A2-2.

The Great Village River provides valuable Atlantic salmon habitat. Within the new corridor, the Great Village River is characterized by predominantly cobble and bedrock substrate with high bedrock cliffs that border the flood plain. These high bedrock cliffs form the west or east bank of the river channel at various locations within the corridor. Excellent salmon spawning habitat is located 40 metres and 250 metres downstream of the proposed centerline, while only small pockets of possible spawning habitat are located upstream of the centerline. An area of moderate quality salmon spawning habitat is located near the downstream edge of the corridor. Figure A2-5 provides an indication of habitat quality downstream approximately 700 metres of the centerline (outside the corridor), to the existing small bridge.

The crossing at the proposed centerline of both the old and new routes is similar. A high bedrock cliff formed the west bank on the old route and an 18 metre high, near vertical, bedrock cliff forms the east bank on the new route. However, good salmon spawning habitat was located upstream of the crossing on the old route, while excellent salmon spawning habitat is located downstream and close to the proposed crossing on the new route.

2.5 Terrestrial Environment

Habitat types within the proposed new highway corridor were identified using aerial photography and ground-truthing similar to that used in the main study. Field surveys were conducted in May of 1992 to verify the habitat type and boundaries, and to check for the presence of unique plants.



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FIGURE A2-5
SALMON HABITAT NEAR THE
PROPOSED ROUTE CHANGE OF
GREAT VILLAGE RIVER CROSSING

TABLE A2-2

Habitat Survey of Water Crossings

Crossing Number	Distance u/s from Corridor (m)	% Bank Stability	Instream Cover	Percent Pool	Stream Substrate					Habitat Quality	
					cl	sl	sa	gr	so		bg
14	0-40	50-75% moderate	5% undercut banks, 20% bedrock ledge	20%	0	0	10	30	30	30	excellent rearing, no spawning
	40-190	50-75% moderate	5% undercut banks, 30% bedrock ledge	90%	0	0	0	30	40	30	moderate salmon spawning/rearing
	190-230	50-75% moderate	5% undercut banks, 5% instream debris	5%	0	0	0	30	60	10	excellent salmon spawning/rearing
	230-420	15 m high cliff to west	5% undercut banks, 80% bedrock ledge	40%	0	0	0	50	50	0	excellent rearing, no spawning
	420-460	50-75% moderate	5% undercut banks, 40% bedrock ledge	60%	0	0	0	45	45	10	excellent salmon spawning/rearing
	460-580	18 m high cliff to east	5% undercut banks, 50% bedrock ledge	100%	0	0	0	50	50	0	moderate rearing, no spawning
	580-730	50-75% moderate	5% undercut banks, 5% instream debris	5%	0	0	0	50	50	0	excellent rearing, no spawning
	730-910	high cliff to west	5% undercut banks, 5% instream debris	90%	0	0	50	30	10	10	moderate rearing, no spawning
	910-1000	50-75% moderate	5% undercut banks, 30% bedrock ledge	5%	0	0	30	30	20	20	excellent rearing, poor spawning

2.5.1 Route Comparison of Habitats

The new route is slightly (250-300 metres) shorter than the old route and as a result less land will be disturbed overall. The area of the various habitat types within the old and new corridors are summarized within Table A2-4. The detailed listing of land types within the new corridor are presented in Table A2-3.

Both routes are covered by predominantly spruce-fir forest in similar quantities with small amounts of maple, birch, beech and white spruce interspersed. The new corridor contains a total of 490 hectares of forested land and 74 hectares of recent clearcut. The old corridor contained 468 hectares of forested land and 53 hectares of recent clearcut. The new corridor contains 44 percent more maple-birch-beech forest, but none of this represents near climax or climax stands.

TABLE A2-4
Comparison of Habitat Areas (hectares)

	softwood	hardwood	clear-cut	agriculture	settled land	blueberries	Total
Old Route	437	31	53	127	8	30	700
New Route	447	43	74	89	2	<1	668

Note: Total area includes 13 ha of wetlands in the new corridor and 14 ha in the old corridor; 18 ha of old field are included in the agriculture area for the old corridor.

2.5.2 Game, Furbearers and Birds

The old and new corridors are similar in terms of wildlife habitat. Both corridors pass through predominately spruce-fir forest, with only small areas of near climax stands. Neither corridor contains rare or unique forest habitat. The new alignment passes through a less settled area, but does not intrude into the major undisturbed forests found further north. The Moose Brook Valley, adjacent to the new route, is already accessible by an all-season gravel road (Spencer Cross Road). Thus, the two corridors are considered generally equal in terms of wildlife

Table A2-3
Habitat Areas within the New Great Village Corridor

Kms/	Elevation	MBB	Alders	SF	SFP	SL	SF-M	P	wS	Br	CC	Plant	Ag	Bb	OldF	GP,RR,PL	u	F	W>60	1B
31	2	23	1	64	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0
Condition		3		2-3																
Suc. Status		E-M		E-NC																
Dom. Species		IH		IH																
				rS																
				bF																
32																				
Condition	2	6	0	87	0	1	0	0	2	0	4	0	0	0	0	0	0	0	0	0
Suc. Status		3		3-4		2			3											
Dom. Species		M		E-NC		E			E											
		IH		IH		La			wS											
				rS																
33	2	7	0	79	0	4	0	0	10	0	0	0	0	0	0	0	0	0	0	0
Condition		3-4		2-3		2			2-3											
Suc. Status		M		E-M		E			E											
Dom. Species		IH		rS		La			wS											
				IH																
				bF																
34	1	0	0	64	0	0	5	0	6	0	15	0	10	0	0	0	0	0	0	0
Condition				3-4			2-3		2-4											
Suc. Status				E-M			E		E											
Dom. Species				IH			IH		wS											
				rS			bS		IH											
				wS																
35	1	0	2	36	0	0	2	0	5	0	20	0	35	0	0	0	0	0	0	0
Condition				2-4			3		3-4											
Suc. Status				E-M			E		E											
Dom. Species				IH			bS		wS											
				bF			IH		IH											
				rS					bF											
36	1	0	0	24	0	4	0	0	0	0	13	0	44	0	0	0	2	0	0	13
Condition				2-3			3													
Suc. Status				M-NC			E-M													
Dom. Species				rS			bS													
				bF			La													
37	1	0	4	48	0	6	0	0	0	0	10	0	0	0	0	0	0	0	0	0
Condition				2-3			2-3													
Suc. Status				E-NC			E-M													
Dom. Species				rS			bS													
				bF			La													
Note: 37 to end of "new" piece (actual kms 36.68)																				
Total Hectares		36	7	402	0	15	7	0	23	0	74	0	89	0	0	0	2	0	0	13

Table A2-3 (Cont)
Habitat Areas within the New Great Village Corridor

Legend:

Elevation:

- | | |
|---|--------------------------------------|
| 1 | predominately between 0 - 249 feet |
| 2 | predominately between 250 - 499 feet |

Land Types:

MBB	Maple Beech Birch Associations
SF	Spruce Fir Associations
SFP	Spruce Fir Pine Associations
SL	Spruce Larch Associations
SF-M	Spruce Fir Maple Associations
jP	Predominately Jack Pine
wS	Predominately White Spruce
Br	Barrens
CC	Clearcut
Plant	Plantation/Cutover
Ag	Active Agricultural Use
Bb	Blueberry Fields
OldF	Old Fields not recently cultivated
GP, RR, PL	Gravel Pits, Railroads and Power Lines
u	Urban Development, primarily residential
F	Fens
W>60	Wetlands ranked over 60 in the NS Wetland Atlas
tB	Treed Bog

Habitat - Condition:

- | | |
|---|--|
| 1 | Regeneration following a disturbance, generally less than 15 years of growth, trees less than 4 m tall |
| 2 | Young, normal growth over 15 to 40 years, trees up to 12 m tall |
| 3 | Young to mature, normal growth over 40 to 60 years, trees generally between 13 and 18 m tall |
| 4 | Mature, good growth over 61 to 80 years, healthy, trees generally 13 to 18 m and taller |

Habitat - Successional Status (Suc. Status):

E	Early Successional
M	Mid-successional
NC	Near Climax
CC	Climatic Climax (old growth)

Habitat - Dominant Species (Dom. Species):

rM	red maple	bS	black spruce
sM	sugar maple	wS	white spruce
Be	beech	rS	red spruce
yB	yellow birch	bF	balsam fir
IH	shade-intolerant hardwoods	jP	jack pine
TH	shade-tolerant hardwoods	rP	red pine
A	aspen	La	larch
		wP	white pine

habitat.

2.5.3 Wetlands

The only significant wetland in either corridor is the large treed bog (approximately 13 hectares) within the Great Village River flood plain. The old alignment passed south of this bog and the new alignment passes a similar distance north. Thus, the two routes appear identical in terms of wetland habitat.

2.6 Existing Social Environment

The proposed new route is predominantly uninhabited except for the southern end where it crosses the Station Road. There are three domestic residences within the 500 metre corridor on the eastern side of the proposed centerline. At kilometre 34+650 a domestic dwelling and barn are situated approximately 400 metres west of the centerline of the proposed route change.

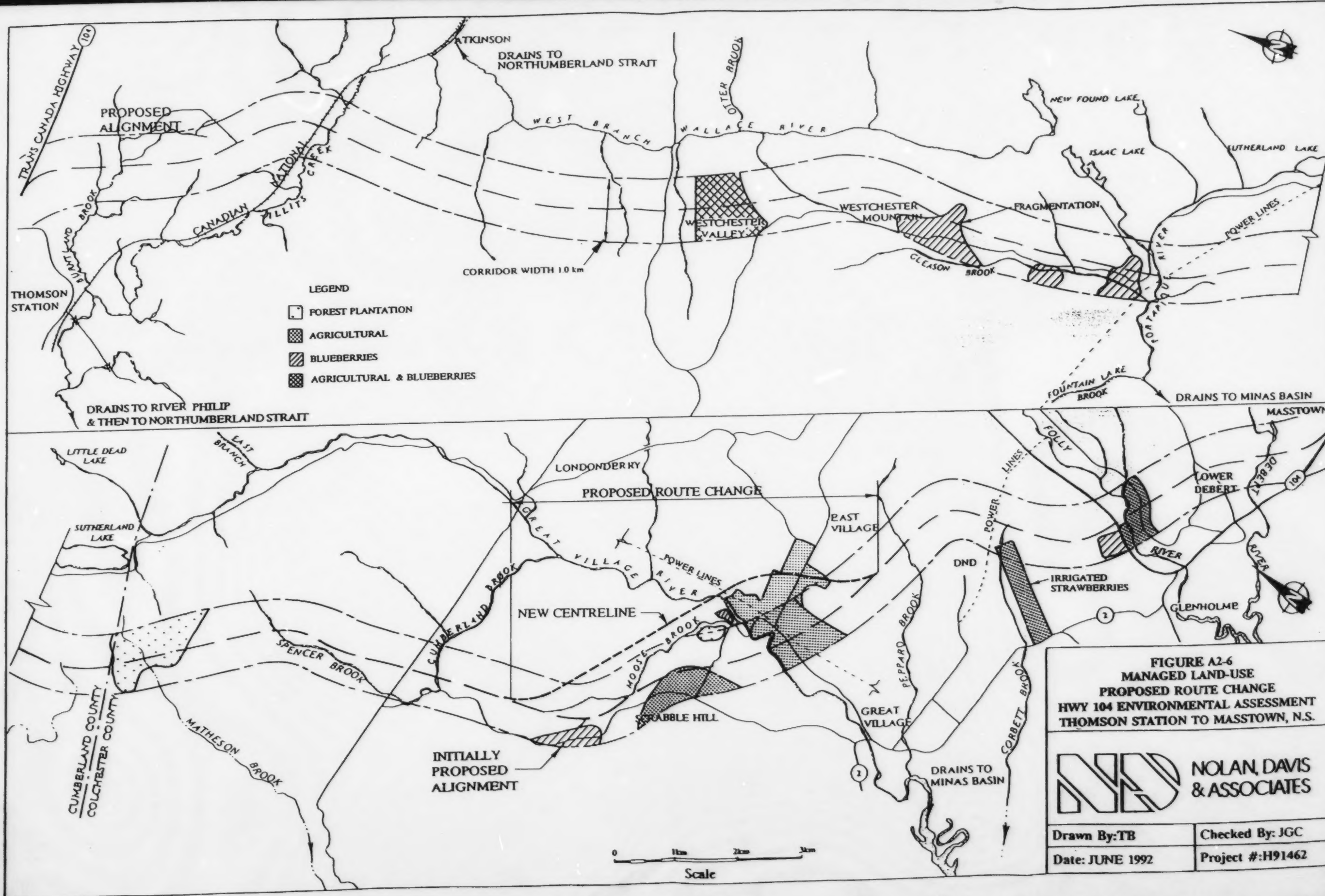
2.6.1 Land Use

The new corridor contains 18 percent less agricultural land and this land falls within a three kilometre stretch in comparison to five kilometres along the old route (See Figure A2-6). Blueberry lands are virtually absent from the new corridor while the old route corridor contained 30 hectares. A small blueberry field (less than one hectare) was observed at kilometre 34+300, about 300 metres south of the original centerline. The new section of corridor also contains 75 percent less settled land, and this land is concentrated in a one kilometre section rather than being spread out across four kilometres, as was the case with the original corridor.

2.6.2 Existing Agricultural Land

During the site reconnaissance to study the various aspects of the proposed route change it was noted that the field due north of the house/barn (kilometre 34+650) had been recently tilled in preparation for the upcoming growing season. Salt licks were also noted in the cleared field immediately west of this location across the Great Village River. No animals were grazing during this visit and the barn on the site was empty. It is likely that this land is used as







alternate pasture for cattle during the summer. The cleared fields noted from kilometre 34+800 to 35+600 are also areas of active agriculture (hay).

2.6.3 Lands of Agricultural Potential

The open field cut by the centerline of the proposed route change at kilometre 33+900 to 34+300 is likely the pasture land of a former farm homestead. Historical mapping and aerial photography indicated the existence of a foundation on the site, however no buildings were noted on the site during the field reconnaissance.

The open field appears to have been abandoned for some time as young softwood/hardwood growth was noted along some edges of the field. Based on the knowledge of agricultural potential this land would likely be designated Class 3 under the Canada Land Inventory classification system.

2.6.3.1 Recreational Land Use

A cleared lot, situated south of the proposed centerline at approximately 300 metres south of kilometre 34+200 and immediately east of Moose Brook is seasonally occupied by a travel trailer during the summer months.

The variety of wildlife, birds and fish identified within the study area are an integral component to the recreational land use in the region. However, it is unlikely that the recreational potential is significantly different between the new and original route alternatives.

2.6.3.2 Forestry Land Use

A relatively small (less than three hectares) Christmas tree lot was identified within the corridor at approximately 350 metres south of kilometre 34+150. This land is bordered by Moose Brook on the east and by Spencer Cross Road to the south. Active harvesting of pulpwood was occurring during the site reconnaissance immediately southwest of this site.

2.7 Valued Environmental Components

The difference in VECs between the proposed new alignment and that described in the main section of the report center on the reduced area of agricultural land, including blueberry barrens on the revised route. Other aspects do not differ significantly between the two routes.

3.0 ENVIRONMENTAL IMPACTS

3.1 Air Quality Impacts

The indicated alignment will impact the air quality of the three residences near the Station Road crossing. Additional study may be required before the roadway design is completed to determine the need for mitigation. North of Station Road, the adjusted right-of-way does not impact on any residences.

3.2 Noise Impacts

The maximum point of impact for this alignment change from the standpoint of noise would be on the three dwellings near Station Road. The impact will be significant for homes adjacent to the right-of-way (ROW). Construction noise will impact on any homes immediately adjacent to the right-of-way or within 400 metres. Any dwellings remaining within 120 metres of the ROW may experience sleep disturbance during the operation of the roadway.

3.3 Aquatic Environment

Impacts on the aquatic environment are described in terms of the sensitivity of the specific streams crossed by the proposed alignment.

3.3.1 The Great Village River Crossing

The crossing of the Great Village River is the only sensitive crossing along the new route. The crossing of the main channel of the Great Village River is particularly sensitive because of the high cliff forming the east bank of the river and the presence of excellent salmon spawning habitat located close to the crossing and 250 metres downstream. There would be a high risk of sedimentation of downstream salmon spawning areas if a crossing was constructed at the proposed centerline. Construction could require rerouting of the main flow away from the cliff edge, possibly requiring elimination of the spawning area closest to the crossing.

3.4 Groundwater Impacts

A drilled well was noted in the front yard of the residence located approximately 400 metres south of the centerline at kilometre 34+600. Details of well construction or quality of this well are not known, however, it appears the well would tap the underlying bedrock aquifer and be of potable nature.

No physical evidence of dug or drilled wells was noted at the private residences situated along the paved road to East Village. However, based on the knowledge of the local geology and the lack of surface water bodies in close proximity to these houses, it is likely that these residences withdraw water supplies from groundwater resources.

The potential impacts on the quality and quantity of groundwater as a result of highway construction and operation can be expected to be the same as those noted in Section 7.2.2 of the main report.

3.5 Terrestrial Environment Impacts

In comparison to the overall route, there are no particularly sensitive features within the new corridor. The large treed bog is the most sensitive feature within the new corridor and it is sufficiently far from the proposed centerline that it should not be directly impacted by highway construction.

3.6 Social Impacts

3.6.1 Heritage Resources

Two experienced archaeologists conducted a pedestrian survey of the proposed route change north of the community of Great Village in relation to the proposed route change. The team, working under Heritage Research permit (Archaeology) number A1992NS08 spent eight hours within the study area. The survey methodology included walking all of the shoreline of the Great Village River and spot checking areas of high potential along Moose Brook and the three unnamed tributaries of Moose Brook situated within the corridor. In addition, informants were contacted and historic maps were verified.

All phases of the survey proved negative. There are no known heritage resources within the corridor of the proposed route change nor were any encountered during the pedestrian survey. Thus, it is the professional opinion of Davis Archaeological Consultants Limited that the proposed route change will not impact on any heritage resources.

3.6.2 Personal and Community Impacts

The relative absence of communities and population along the proposed route change means few individuals will be directly impacted as a result of the highway construction. No public perception studies were undertaken specifically for this assessment, however, those who do live within the corridor and particularly those living in the three residences near Station Road will be impacted by the highway.

3.7 Summary of Impacts

The impact of the proposed new route will be generally similar to the original route as indicated in Figure A2-7 except that it meets the primary objective of reducing the impact of the highway on productive agricultural land.

4.0 MITIGATIVE MEASURES

The proposed route change requires specific mitigation over and above the generic highway issues identified in Part Eight of the main report at the Great Village River crossing. Construction of the crossing of the Great Village River at the proposed centerline could impact on valuable salmon spawning habitat. However, the high bedrock cliffs bordering the floodplain are substantially lower near the mouth of Moose Brook. Consideration should be given to shifting the centreline approximately 300 metres downstream (within the corridor assessed) to avoid the sensitive spawning habitat and to take advantage of the smoother terrain.

5.0 CONCLUSION

On the grounds that the proposed change in route meets its primary objective of reducing the impact of the highway on developed agricultural land in the area without significantly adding to impacts in other areas, it is recommended that the proposed change be adopted. Consideration should be given to changing the detailed alignment at the Great Village River Crossing so as to avoid steep cliffs in the area and otherwise minimize impacts to the stream.

FIGURE A2-7
Summary of Negative Impacts
Proposed Route Change - Great Village River

PROJECT ACTIVITY	AIR		WATER			LAND			SOCIAL		
	AIR QUALITY	NOISE	SURFACE WATER	GROUNDWATER	FISH	CLIMAX HARDWOODS	WETLANDS	WILDLIFE	CULTURAL RESOURCES	LAND USE	SOCIAL
<u>Planning/Activity</u>											
Access/Surveying											•
Environmental Assessment											
Property Aquisition										○	○
<u>Construction Phase</u>											
Clearing	•	•	○	●	○		•	•	•	○	●
Grubbing	•	•	○	●	○		•	•	•	○	●
Blasting	•	•		○				•	•	○	●
Excavation	•	•	○	●	○		●		•	○	
Fill Operations	•	•	○	●	○		●		•	○	
Stream Crossings			○		○		•				
Paving	•		•								
Contingencies - spills, etc.			●	●	●		●	•		●	●
<u>Operational Phase</u>											
Snow Plowing			•		•		●	●			
Salting		•	●	•	•		•			●	
Runoff			●		•		•				
Traffic Impacts		•	●	●	●			●	•		•
Bridges Culverts Maintenance		•	○		○		○				
Pavement		•									
Contingencies - spills, etc.			●	●	●		●	•		•	•

Key:

- Low Impact
- Significant Impact, Mitigable
- Significant Impact, Non-mitigable
- Significance of Impact